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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 196

Contribution from the Bureau of Chemistry
CARL L. ALSBERG, Chief

Washington, D. C. PROFESSIONAL PAPER May 29, 1915

METHODS FOLLOWED IN THE COMMERCIAL CANNING OF FOODS

By

A. W. BITTING

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By A. W. Bitting.

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MODERN FACTORY EQUIPMENT AND METHODS.

METHODS OF STERILIZATION.

Sterilization may be accomplished by heat below, at, or above the boiling temperature, depending upon the length of time the heat is applied and the number of applications made. It is not practicable to sterilize all foods in the same way because of injury to quality or prohibitive expense. Sterilizing below the boiling point is feasible only for a few products, principally fruits, and then is advisable only when it is desired to preserve a very fine appearance. This may be accomplished above 165° F. by maintaining the temperature for a longer time than when boiling, or by repeating the operation on two or more successive days. The object is to prevent breaking the tissue and loss of juices from the fruits by excessive heat. This method of sterilization has been applied experimentally and in private canning with gratifying results, but it involves so much time and labor that it is not used commercially except in a limited way. Sufficient work has not been done to say definitely what products can best be treated in this way nor what temperatures are best suited for different foods. It has been used chiefly with foods in glass, though equally satisfactory results are obtained with foods in tin.

Cooking at boiling temperature is practiced with nearly all fruits, as the germs present are easily destroyed. Most of the fruits are processed for from 12 to 25 minutes.

[1] A revision of Bureau of Chemistry Bulletin 151, enlarging upon certain phases of the manufacturing processes, and incorporating a summary of the results of the experimental work of the season of 1912 and 1913. Since the information includes only the methods of commercial canning, it is of no interest to the home canner. Presentation of the trade practices does not imply an indorsement by the Bureau of Chemistry. Prepared by A. W. Bitting while food technologist of the bureau.

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The tomato is the most important vegetable processed at boiling temperature, which is usually maintained for 50 minutes.

Cooking at a temperature above the boiling point is necessary or advantageous for most vegetables, fish, milk, and meats. It is accomplished in retorts where steam is admitted under pressure, in retorts where water can be superheated, or on the open calcium chlorid or oil bath.

Among the vegetables requiring a high temperature in processing are corn, peas, beans, both green and dry, pumpkin, beets, and sweet potatoes. Corn is one of the difficult products to can, requiring a temperature of from 245° to 250° F. for from 75 to 80 minutes, depending to a considerable extent upon how dry it is packed. If very dry, the heat will penetrate to the center of the can very slowly, the actual time required to raise the center to the temperature of the bath being from 55 to 65 minutes. In a can of peas this is accomplished in 6 or 7 minutes, the difference being due to the fact that heat currents are set up in the liquid portion of the peas, while they are absent in the corn. The necessity for a high temperature is therefore dependent upon the ease with which the heat can penetrate the product, as well as the resistance of the organisms. Some products which were formerly processed by boiling for a long time are now given a higher temperature for a few minutes, as the product has a much better appearance when it is not overcooked.

Meat products, as a rule, contain highly resistant organisms, besides which the majority of these foods are of such a consistency that the heat penetrates them very slowly. As a class they require the heaviest process. Milk also contains very resistant germs, but being liquid it heats rapidly; in order to keep it smooth and prevent the portion in contact with the tin from scorching, the cans are turned or agitated almost continuously during the cooking.

DETERMINATION OF TEMPERATURE AND TIME OF PROCESSING.

In sterilizing, the heat must be applied equally to all cans, and it is therefore necessary to deliver steam at the bottom of the kettle, whether open or in a retort, to insure a circulation of the heat. In retorts, whether steam or hot water is used, there must always be a vent open to give off steam in order to hold the heat uniform at all points. The thermometer is the all-important tester, for if it does not show the proper degree of temperature, spoilage will follow. To test the uniformity of temperature in a retort, self-registering thermometers are sealed in a number of cans when placed in the crates, the cans are marked, and when the cooking is completed the thermometers are examined and compared, so that the heat may be adjusted until all give like readings. In a similar manner the time required for the heat to reach the center of the can is obtained, experimental lots being run for varying periods, and the temperature noted. The calcium chlorid or oil bath acts in the same way as the open water bath.

The writer employs two methods of determining the temperature in the center of a can and the rate of penetration. First, a thermometer is placed in a packing joint which is soldered into the can so that the bulb will just reach the center. By placing a collar an inch above the gasket the can may be submerged in oil and heat applied until a certain temperature is reached. The length of time necessary for the thermometer inside the can to reach the same point as that on the outside, or within from 2 to 5 degrees of the outside, as experience demonstrates may be sufficient, must be allowed in the retort and the heating then continued for such an interval as may be found necessary for sterilization. For example, if the spores of certain organisms are killed at 230° F. in 12 minutes, and it should take 20 minutes to cause the content of the can to become heated, it would require 32 minutes as a minimum for processing, and as a margin of safety the recommendation would be for a longer time, probably for 40 minutes.

The second method of determining temperature in different parts of the retort and in the center of cans is to seal a thermocouple in the can and connect it with a record-

ing apparatus. Thus a time and temperature curve is obtained directly. One of the important points learned from the latter apparatus was the effect of stirring or agitating the contents of cans which ordinarily required long cooking. A can of corn in a retort requiring 65 minutes to reach 245° F. requires only 30 minutes when rolled back and forth. The effect of the agitation was a shorter cooking, a brighter color of the corn, and a bright can on the inside. The principle is good, but some mechanical difficulties in successful operation have yet to be overcome.

The penetration of heat in the can is dependent almost wholly upon the ease with which convection currents are set up, occurring most rapidly in products which permit the free circulation of water, weak brine, or sirup between the solids, as in peas, and least rapidly in the absence of free liquid, as in dry-packed sweet potatoes. Products having a heavy though uniform consistency, like pumpkin and squash, require a long time for heat to penetrate to the center of the can. Heavy tomato pulp takes a much longer time to reach the boiling point than canned tomatoes, and soft ripe fruits, as apricots and peaches, need more time to become sterilized than green fruit, not because the germs are more resistant, but because the heat can not penetrate as readily as when the liquid circulates freely between the solid pieces. Failure to recognize this principle of the movement of heat in liquid, semi-liquid, and solid substances has caused the loss of thousands of cases of foods. Mechanical agitation shortens the period of cooking, especially in foods of heavy body; at the same time it places a greater strain upon the can, with a tendency to increase the number of leakers.

The varying temperatures and methods used in canning cause strains upon the containers, which may be comparatively light or so severe as to cause leakage. The contents expand as the temperature rises above that at which the sealing was done and contract as it goes below that point. The internal pressure, therefore, reaches the maximum in foods packed cold and processed at the boiling point or above in the open, and, conversely, the vacuum is highest in those filled near the boiling point and stored very near that of freezing. If the processing be done in a retort, the internal pressure will be the same as that induced by heating to 212° F., plus the number of pounds used in the retort, but a strain is produced only by such part of the pressure as is developed in bringing the contents to the boiling point as long as the retort is closed. For example, if a can of peas be sealed at 160° F., placed in a retort, and processed at 240° F., the can will first be subjected to a steam pressure of about 10 pounds from without; the internal pressure will rise until the temperature has reached 212 °F., at which point the pressure will show about 5 pounds, and as the temperature approaches that of the retort the pressure will show about 15 pounds, only 5 pounds of which will exert any strain until the retort is opened, when the whole becomes effective, gradually decreasing as the cooling takes place.

If, however, when the process is completed, the retort remains closed and a stream of cold water is admitted to chill the cans, the first effect is to condense the steam in the retort suddenly, thus causing a vacuum. This has the effect of removing 15 pounds of atmospheric pressure from the outside of the can or virtually adding the equivalent of that much pressure within, giving a total of about 30 pounds internal strain. This is sufficient to break some cans, particularly No. 3 or above, and accounts for many slow leaks. The more suddenly the strains occur, the greater the percentage of leaks. Processing in retorts is accomplished with little loss, if on admitting the steam the pressure be gradually applied for a few minutes and in turning off a vent be opened and a little time be given to cool.

In order to work the retorts rapidly and avoid the severe strains, air may be introduced under a pressure equal to that of the steam as the latter is being turned off. Water for cooling may then be introduced without danger. By this method square cans, gallon and even 5-gallon cans may be processed without the losses formerly experienced. In the open calcium chlorid or other bath the cans are subjected to the maximum internal pressure throughout the entire operation.

The effect of the sudden production of a vacuum, due to condensing steam inside the cans, may be seen in the strongly collapsed sides when they are played upon by a stream of cold water. Number 3 cans, if a little slack-filled, or gallons will present the appearance of being battered. If such cans, resting upon their sides instead of on end, so that the stream is along the upper side, are struck by cold water, the collapse at the one point may be so severe as to cause buckling or even breaking of seams.

After the processing is completed, the pressure decreases inside the can until, theoretically, it becomes zero at the temperature at which the sealing was done and becomes a vacuum at temperatures below that point. As a matter of fact, however, a weak vacuum is always found at the temperature of sealing, due to changes in the product or to the action of the product upon the container in processing. Cans sealed at 160° to 180° F., and stored at from 60° to 80° F. will show a very strong vacuum, while those packed cold or nearly cold and stored in a warm place will show no vacuum and may show actual pressure, becoming springers.

SANITATION.

A modern cannery is no longer the rough, crude shed that once was thought to be sufficient for this purpose. First of all the location must be sanitary, away from manufacturing processes which of themselves are objectionable, such as soap making, tanning, rendering fats, or any other processes which may give rise to noxious odors or may be productive of organisms of decomposition. The yards and drives about the factory should be cleaned daily, and in summer dust should be prevented by frequent sprinkling or by the application of crude or specially prepared oil to the drives. The application of oil is especially to be recommended where there is much hauling and there is no pavement, or the factory is to be run for a short season only, as in the case of tomatoes. A single application made a couple of weeks before the season opens will suffice for several weeks; if the oil is put on early it will become incorporated in the earth and not be tracked into the factory to any great extent. The drainage must be such as to prevent any surface overflow from adjoining property, and also be ample to keep the stock in good condition at all times. It should be ample to care for the waste, as this is sometimes a serious problem. If the natural body of water available is not sufficient, settling tanks or filters may be necessary. Fermenting material, such as tomato trimmings or corn refuse, should not be tolerated within or near the factory. The supply of water should be sufficient for all purposes and of good quality; that used in washing, blanching, and brining should be free from excessive hardness or iron, otherwise the finished products may be damaged. If the water for this purpose is not naturally of the right quality, artificial treatment may be necessary. The water used for washing about the factory should have a good pressure for cleaning. A factory with a poor location, or an insufficient or poor water supply, has a handicap which is difficult to overcome. The facilities for bringing in or sending out stock should be ample, so that materials used need not be delayed, especially when it may mean deterioration.

The buildings should be designed with reference to the special products to be packed, but there are some features which should be common to all. The ceilings of all rooms should be high, with ample provision for light and ventilation. The light should come from numerous side windows, or, if the rooms are large, from turrets, or a saw-tooth-roof construction. Either of these two arrangements can be made to give a flood of light and at the same time provide good ventilation. An advantage in the saw-tooth construction arises from the cooling and drying effect. When the straight section, or windows, is turned toward the north, the sun beating upon the southern incline will heat the layer of air underneath, causing it to rise. This creates a circulation within the room which tends to dry floors and tables and to lower the temperature. Tests made in factories so constructed have shown several degrees lower temperature on hot days than was recorded in factories having the usual form of roof.

One of the marked contrasts between the newer and older construction is the provision for plenty of light. Light has a beneficial effect upon employees, contributes to cleanliness, and is an active, constant disinfectant. High ceilings and proper roof construction usually render artificial ventilation unnecessary, but if mechanical measures are employed, a blower system with provision for cleaning the air is to be preferred to suction. An abundance of light and air is a combination which will contribute to the maximum of labor efficiency.

A tight, hard floor is a necessity, and in all rooms where manufacturing processes are conducted it should be pitched about 1½ inches for each 10 feet. The pitching should have special reference to the position of machines and tables where there will be more or less water or waste, so that this may be confined and the floors be flushed clean and kept reasonably dry with the minimum of labor. There should be frequent trap connections with the sewer. The kind of material best adapted for a floor will depend in a measure upon whether it is to be used for dry work and storage or whether water is employed more or less freely. Factories having a short packing season, as in the case of tomato canning, find concrete to be the best. Wood shrinks, swells, and cracks with changes of moisture; the cracks are hard to clean, leakage is almost certain to occur, and these conditions become aggravated in factories which are idle a part of the time. Wood with a smooth covering, such as sheet roofing, makes a good floor, but will not last long. Concrete is more or less porous, wears rough, and is not an ideal floor, but is the best for certain conditions. Asphalt wears away and crumbles too easily. Upper floors should not be chosen for food preparation if plenty of ground space is available, for the reason that it is difficult to keep them tight. Furthermore, the work can be supervised to better advantage on one floor than on many, unless the departments are so large as to demand a superintendent in each. Conveyers can be obtained to handle products from one machine to another, and these are more easily kept clean than are floors. Conveyers and overhead tracks should be used in handling the product as far as is possible, in preference to trucks, as the latter are destructive of floors and are not so clean.

The use of slat gratings to cover the floor about the kettles or other places where there is a splashing or overflow of water is especially to be commended. These may be made in sections about 2 by 4 feet, and can be taken up for cleaning. There is no excuse for floors being so wet or sloppy that the workers must wear rubbers, which is sometimes the case. All side walls, partitions, ceilings, and supports should be smooth, to admit of easy cleaning. Preferably they should be light-colored and, as far as possible, of such material as can be washed with a hose, as this is the easiest method of cleaning or of applying whitewash. Some factories need to be divided by partitions to prevent unnecessary heating by steam from the cookers. In other cases the room where the material ready for the can is kept should be separated from the rooms in which the preparation is going on, in order to protect it from dust. That part of the factory in which prepared material is in any way exposed should be screened to keep out flies and dust. This precaution is often of greater importance than the protection of the workroom, as during the working period the moving of machinery and escaping steam will drive away insects.

The tables used in the preparation of foods should be plain and of a material that is easily cleaned. There should be no sharp angles or grooves where waste can accumulate, nor any places beneath where material can be stored. Hardwood, such as maple or ash, is probably the best material for the majority of factories. These woods will absorb little water or juices, they show soil quickly, and clean easily with soap, water, and scrubbing brush. Opal glass or porcelain makes excellent table tops, but is expensive. Enamel-coated metal has come into use, and under certain conditions gives excellent results. The important point is that the tables may be cleaned easily, and that it be done often. The machinery used should be of the most sanitary type and set in such a manner as to be accessible from all sides for cleaning. Con-

veyers for fruits, tomatoes, and all other products should have automatic washers and brushes in their course to keep them clean. The amount and kind of equipment varies greatly, depending upon the product. Peas, corn, and beans require the most, fruits the least. The details of the special requirements will be considered under each product. Water and steam pipes, with hose attachment, should be conveniently placed about the factory for cleaning tables, machines, floors, walls, and ceilings. This is a necessary part of a modern equipment.

Provision should also be made for the cleanliness and comfort of the employees. Water should be placed at convenient places that the workers may wash their hands often, and sanitary drinking fountains installed to take the place of the common cup. A factory is not complete without proper toilet and clothes rooms. The toilet should have facilities for washing the hands with soap and water and hand brushes should be provided. There should be lockers for storing the outer clothes, as wearing apparel should not be hung about the factory. Providing special suits and a manicurist are refinements which are found at some factories and are not so much of an extravagance as less progressive firms would argue. For factories running continuously and employing the same help uniforms are advantageous. For such operations as picking, peeling, and pitting fruits, which may be done as well while sitting as standing, stools should be provided. Standing all day at tables is more than tiring; it is exhausting and decreases efficiency. This is clearly evident to every factory inspector, especially after the season has advanced. The stool is to be preferred to the common bench, so that the individual may stand or sit as may be most comfortable. If standing in one place over cement floors is necessary, wooden springboards should be provided for the restful effect upon the feet. The various States provide the general conditions under which labor may be performed, as age limit, number of working hours in the day or week, and physical condition. No person affected with a disease should be employed in a food factory.

METHODS AND PROCESSES.

The steps in canning will vary with the product, but, in general, there are certain processes which are common to all and may be described in this outline, as receiving the product, grading, washing, preparing for the can, filling, exhausting, capping, processing, and cooling.

Raw Materials.

The first requisite in all canning is that the product be delivered in first-class condition, fresh from the fields or orchard, and in a manner to prevent injury. Fruits, such as berries, must be handled in boxes as for the market, tomatoes in shallow crates, corn, peas, and beans in such quantities that they will not heat, and marine products cold or chilled and in compartments to avoid bruising. The condition of the material on delivery is of the greatest importance, and for that reason the factory should be located near the point of production, or, if shipment be made, it should be for only a short distance and on a direct line. A cannery which depends upon long-distance shipments or purchasing the supplies on a city market will generally be found to put out an inferior article. In any delivery the seller should be held responsible for the condition of the material; the grower has no more right to deliver decayed tomatoes than the canner has to use and ship them. The first case is usually a violation of a State law and should be dealt with accordingly; the second may be reached by Federal statute if the shipment becomes interstate.

Grading.

The second step, that of grading or sorting for quality, is of great importance. A general inspection or classification of all products is made by the foreman at the time of receipt, but this is insufficient. The real grade of any product depends upon the quality of the original stock rather than upon the sirup or brine added or any sub-

sequent operation, and the best time to make a separation is before the work of preparation is begun. A large part of the sorting can be done better by a few specially trained helpers, although some of it may be continued in subsequent operations. The hard and faulty ears of corn may be picked out more easily while it is being conveyed to the silker than later by the cutter feeders, who are very busy keeping the machines working and can not take the time to sort properly. A few persons can pick out green, defective, and wrinkled tomatoes which will not peel economically and do it better before the fruit reaches the scalder than the peelers can do. The same principle holds true for peaches and many other products. Those who peel or fill the cans should have the minimum of grading to do. The sorting is usually done upon belts or special table tops to expedite the work. Berries are picked, stemmed, and defectives picked out when graded, to save handling.

Washing.

The next operation is generally that of washing, the method depending upon the material canned. In general, most products are placed in a tank of water to loosen adherent dust and dirt, gently rolled over by the agitation of the water, and then sprayed as they emerge. Since the spraying is the important step, it is desirable that the water have force rather than a large volume. A small spray with force will cut off dirt and adherent mold very successfully. The principle is the same as cleaning a floor with a hose having a nozzle, or with one having an open end; the former will use less water, but will clean better. Some hard-coated products, as peas, are washed in revolving wire cylinders, known as "squirrel cages." Soft fruit, such as raspberries, require very gentle washing, and if the fruit appears clean some packers object to washing it at all, claiming that it causes injury and loss of flavor. Whatever method is used, the cleaning should be thorough.

Preparation and Blanching.

Many of the fruits need no special preparation other than cleaning and sorting, after which they are placed directly in the cans. Fruit like peaches, apples, and pears must be peeled and cut to the proper size. Nearly all vegetables require more or less treatment; peas are shelled, graded for size and quality, and washed and blanched by automatic machinery; corn is cut, silked, brined, and cooked; beans are snipped and strung, graded for size, and blanched; asparagus is cut into lengths and blanched; sweet potatoes and beets are peeled and graded, and so on. The operation of blanching is in reality parboiling. Vegetables are dropped into boiling water for from one to five minutes, as a rule, to cause softening, and at the same time to remove some of the mucous substances which form upon the surface. The effect produced by a short boiling in the open as compared with boiling in the closed can is surprising. Peas or beans which are a little aged and hard will soften quickly in the blanch but retain their condition in the can. In almost any case of very cheap peas some may be picked out which, if thrown upon a table or the floor, will bounce a couple of feet or more. This is evidence that they were not properly blanched and that softening did not take place in the can. The operation of blanching is of much importance in putting up good vegetables. It is not a matter of whitening, as the name might seem to indicate, though it does have the effect of producing a much clearer liquor than would otherwise be present.

Washing and Filling the Cans.

The cans should be washed just prior to being used. In the shipping and storing more or less dirt and dust find lodgment on the inside, and washing is the only method of removing it. The quantity of dirt which can be obtained from a thousand cans is usually a matter of surprise. The work is done very effectively at the present time

by machines. The filling may be done by hand or by machine. There are many products, especially fruits, which can not be successfully filled by machine because of crushing or otherwise injuring them. When filled by hand, the contents should be regulated by weight rather than by volume, so that the finished product will be uniform. If the filling be done by machine, care should be taken to get the best results possible. It is illogical to use care in peeling a 3-inch tomato and then have it squeezed through a 2-inch opening in front of a crude plunger, or that great care should be exercised in washing and blanching peas which are to be run through a filler that will cut or crush enough to make a muddy liquor. Machines should be designed to fill with reference to the nature of the product and not to be merely "can stuffers." Vast improvements have been made in filling machines in the last few years, so that most of the work can be done with nicety and precision. All filling machines operate upon the principle of delivering a certain volume rather than a given weight, and for most products this method is very satisfactory. In all cases, whether the can be filled by weight or volume, the amount of material used should be all that can be put in the can in first-class condition. Brining and siruping have also been improved, the old-fashioned unsanitary dip box giving way to a sanitary filler.

In filling the cans head space equivalent to at least one-fourth of an inch for No. 2 cans and about three-eighths of an inch for No. 2½ and No. 3 cans should be left. The amount of head space needed depends in a measure upon the nature of the product, but without some space the production of a small amount of gas will destroy the vacuum. In the hole and cap cans this space is available, because the sealing can not be done without some room, and as a result springers are rare. The tendency is to overfill the open-top cans. If the product is poured in the cans very hot, 180° F., the expansion which it has undergone will insure sufficient space. In general, any fruit or vegetable sealed at a temperature of 160° F., or higher, will have sufficient head space to prevent springers or flippers. The later types of sanitary capping machines are provided with plungers to squeeze out the overfill of cans. This works well upon such products as have liquids, but fails upon all solids, as sweet potatoes.

Exhausting.

After the cans are filled they should be exhausted—that is, heated until the contents are hot and as much as possible of the air driven out. This process is not considered necessary for articles that are subjected to forecooking, as corn, or for those that are kettle cooked and filled hot, and it is not generally employed with such products as peas and beans, which receive a hot brine, although it is advantageous even under these conditions.

The time required for exhausting depends upon the degree of heat required in the product and the rate at which it penetrates. For such products as corn, peas, beans, pumpkin, squash, and sweet potatoes, a temperature of 180° F., or higher, is desirable. For fruits and tomatoes a temperature of 135° F. will suffice. With good equipment, the work can be done in from one and one-half to eight minutes. For products which will stand the high temperature the steam is turned into the heater under a fairly strong head and the perforated pipe made to spray directly against live steam pipes, so that it may have the effect of superheating. With fruits the heating should be less vigorous and the time rather extended. Too high a temperature causes fruit to swell and float on the top of the sirup, as well as to soften and break open, and it is better to take four or five minutes, rather than two minutes, in reaching 135° F. For hard pears or peaches an eight-minute exhaust will give a better article on the "cut-out" [1] than is obtained by so much extra cooking in the can. For tomatoes a rather

[1] The "cut-out" is the finished product and is judged by appearance, color, consistency, odor, flavor, and weight of contents as a whole and of the solids and liquids separately.

hard exhaust for three minutes is usually employed, but a better result is obtained when a lower temperature is maintained for five or six minutes. Meats and fish are held from 8 to 20 minutes in a vigorous exhaust. Milk is one of the few products packed cold.

One of the difficulties connected with thorough exhausting has been that it causes expansion of the contents, so that the solids float on the top, which makes capping difficult. This is now obviated with the open-top cans by attaching the covers and crimping them lightly before they enter the heater, thus holding the solids in, at the same time permitting the expulsion of air. It also makes possible the sealing at a higher temperature than formerly. The importance of thorough exhausting has been established in connection with studies upon the effect of the contents on the container. Some products which have shown a rather high content of dissolved salts of tin are found to have much less when well exhausted, and practically all show some diminution.

A well-exhausted can shows 8 inches or more of vacuum when the can is cold. The average of a number of experiments gives the vacuum reading at room temperature, where the tipping was 200° F., 16.5 inches; 190°, 15.4 inches; 180°, 13 inches; 170°, 10 inches; 160°, 8.5 inches; 150°, 8 inches; 140°, 7 inches; 130°, 5 inches; and 70°, 1 inch. There are many cans which show 15 inches of vacuum shortly after being put up, but this gradually decreases as the pack stands, the rate depending principally upon the activity with which the product attacks the container.

Capping and Testing for Leaks.

Open-top cans are sealed by a special machine known as a double seamer. The lid is pressed into place and steel rollers crimp it on without acid or solder. This action is automatic, a single can at a time, but at the rate of 30 per minute, or 1,800 per hour. Cans with solder tops are sealed by automatic machinery, 12 at a time, 85 per minute, or 5,000 per hour. The top is wiped, the cap placed on, acid applied, the hot soldering irons drop into place, and the vent is afterwards closed, all in one series of operations, without touching by hand. As the cans pass from the capping machine they may be submerged in a bath of boiling water to test for leaks. Any imperfection in the can or defect in sealing will be shown by a series of air bubbles issuing from the opening, and the can is at once taken out by the inspector for repairs.

Processing and Cooling.

After capping, the cans are processed according to the nature of the contents. The cans are collected in large iron baskets, which usually hold 270 No. 2 or 180 No. 3 cans, and three baskets fill a retort. If the processing is conducted at boiling temperature, the retort is not closed, but steam is turned into the water which covers the cans. If the temperature is to be above the boiling point, the retort is closed and either the steam is turned into the retort until the proper pressure and temperature have been reached, or water is first turned in to cover the cans and the steam is admitted until the temperature has been attained. In processing fruits it is customary to use long vats containing boiling water and equipped with automatic conveyers, which carry the cans or crates through at a speed sufficient to process them for the necessary length of time. This period varies with the product. Sterilization depends on administering the proper amount of heat, and heating above the required temperature or for longer than is necessary only cooks the material to no purpose.

As soon as the processing is completed, the cans should be cooled with water. Unless this is done, the heat will be held so long that the contents become overcooked—fruits are softened, and tomatoes become liquid, even blacken, peas break and make muddy liquor, while corn acquires a brown color and a scorched taste. The cooling may be done by turning cold water into the retort, by removing the

basket of cans to a cooling tank, or by spraying with water in the air. There is less difference in the results obtained by different methods of applying either heat or cold than some claim; the important point is to accomplish these steps quickly.

In canning operations the product, salt, sugar, or other seasoning, and water are the only materials used. No hardener, bleach, or preservative is employed, and in commercial canning there never was as much preservative used as is common in the household operation. Saccharin and sulphites were formerly used in corn and peas, but their use has now been practically discontinued; on the other hand the practice of selling a "canning compound" to housewives still continues, and will only cease when the nature and effects of such chemical preservatives are known, and the lack of necessity for their use is appreciated.

CONTAINERS.

The first container used was the ordinary glass bottle with a comparatively small mouth and closed with a cork. The next step was the use of a resinous wax to cover the cork. The bottle was modified to the more convenient or jar form, and a groove run around the top so that a tin cap might be sealed in place with wax. This method of sealing was common in domestic canning until about 1890. The metal screw cap with the rubber ring and various other devices, most of which depend on a rubber or fiber joint to exclude the air, have been introduced since that date. The glass jar is largely used in domestic canning, but not commercially, as it is heavy, breaks easily, can not be handled by automatic machinery, will not stand hard processing without special precautions, and increases freight rates. Glass containers are used for preserves, for spiced and pickled fruits, and for the limited canning for which the consumers are willing to pay a fancy price. Very recently improvements have been made in glass jars and the methods of sealing, which may extend their usefulness, especially to such products as can not be preserved to the best advantage in tin.

The earthenware jar was brought out to offset the high cost of the glass jars; some of these were glazed inside, some outside, and some on both sides. They were generally sealed with a tin cap by means of wax, though a few had earthen tops. Various forms were given to these jars, and some may still be found which have been in use for many years in rural districts. The earthenware jars had only one advantage over glass, that is in cost, but they had the disadvantage of having blow or sand holes. The earthenware jar is not used to any large extent in commercial canning, though some are used to pack bulk jams and stock for preserves, etc.

The tin can is preeminently the container used in commercial canning, and it is also used to a very large extent in home canning. Those used for the latter purpose retain the deep ring about the opening for the insertion of caps and sealing with wax; these are commercially known as wax-top cans. In commercial canning solder is used exclusively for sealing stud hole or cap cans. The tin can has undergone a number of changes. The first cans had flush sides and ends, or plumb joints; these gave way to the stamped-overlapped ends, and all inside solder has been superseded by lock seams and outside soldering. Most solder caps are hemmed, so that only the amount necessary to seal is used. The solder can has been superseded in many cases by the open top, or so-called sanitary can, and in this case the sealing is done by double seaming on the top, no solder being used on the can except in making the side seam. The former objections to acid and solder, on the ground that they contaminated the foodstuffs, have thus been largely overcome.

The most recent improvement in the tin can is the inside coating or lacquering. This type of can is known to the trade as the "enamel lined" can. Various coatings

have been tried at different times without entire success, and while the present lining is not perfect, it does effect a marked improvement in many lines of packing. There are fruits and vegetables which attack the tin coating with more or less vigor, resulting in a loss of color, flavor, and quality, and at the same time form salts of tin which are objectionable. The inside-lacquered cans are especially effective in holding such articles as raspberries, cherries, plums, beets, pumpkin, and hominy. They do not add to such products as corn, peas, beans, tomatoes, or those which have little action upon the tin. Inside coating is accomplished in two ways—by baking the lacquer on the sheet and by spraying it on the inside of the finished can; further improvement in the container may be expected along these lines.

The tin can is made in a great variety of sizes and shapes, but there are certain forms known as standard.

Sizes of standard cans.

Number of can.	Diameter in inches.	Height in inches.	Capacity in ounces.
1	$2\frac{1}{16}$	4	11.6
1 tall	$2\frac{1}{16}$	$4\frac{1}{2}$	12.3
2	$3\frac{3}{8}$	$4\frac{9}{16}$	21.3
$2\frac{1}{2}$	4	$4\frac{3}{4}$	31.2
3	$4\frac{3}{16}$	$4\frac{7}{8}$	35
3 tall	$4\frac{3}{16}$	$5\frac{1}{2}$	39
8	$6\frac{3}{16}$	$6\frac{7}{8}$	104
10	$6\frac{3}{32}$	$6\frac{3}{16}$	107

The size of package used for certain products is fixed by trade custom and not by the needs of the consumer. For example, corn, peas, beans, and such products are almost exclusively packed in No. 2 cans, tomatoes in No. 3, and California fruits in No. $2\frac{1}{2}$ cans. The No. 2 can of high-grade peas or corn contains about 22 ounces, or too much for one service for a family of two, three, or four persons, and with peas in particular the unused portion is not so good when served a second time. A can holding 16 ounces would more nearly meet the requirements. The same is true for a No. 3 can of tomatoes. The excess is waste in many cases and represents not only good material but the labor expended upon it, a larger can than is necessary, and boxing and freight. These are all items which contribute to cost and a consequent lessening of the use of canned foods. The No. $2\frac{1}{2}$ can was developed as a short weight from the No. 3 and does not adequately represent the interval in size between the No. 2 and the No. 3. The No. $2\frac{1}{2}$ sanitary can holds only slightly less than the No. 3 in the older style, as the latter can not be filled so nearly full and sealed. Recently a new style of can has been introduced for California fruits, especially for peaches, known as the luncheon size, which is one-half the height of the No. $2\frac{1}{2}$. These are desirable because they will take in the large pieces of fruits and apparently are meeting a demand. The same style in the square can is being used for asparagus tips.

At the present time some packers are trying to meet certain demands by varying the fill rather than the size of the can. For example, a well-filled can of tomatoes might retail at 15 cents, the packer may reduce the quantity, add water, and make the cans sell two for a quarter, or carry it to an extreme and sell for 10 cents. A customer finding that the 10-cent can will furnish the amount of tomato wanted and without waste will repeat the order. The same methods are used more or less in packing fruits, using a quantity which will make the can sell for a certain price. This is a crude, unsatisfactory, and manifestly expensive method, and also open to fraud by those who are unscrupulous. It would be far better for the packer to determine what size is wanted and use such sizes, filling them properly.

THE LABEL.

The label should tell the truth in terms which are direct and easily understood. It should give the name of the article, the grade, by whom packed and where packed, or the name of the distributor. Neither the names nor the illustrations used should be misleading. A picture of green peas in pods in clear relief and subdued type stating that the contents are soaked is hardly appropriate. If given a geographical name it must be the true one. Corn grown in Iowa is not Maine corn though obtained from Maine seed. The use of such terms as "Maine style" for cream corn is in reality only an attempt to circumvent the intent of a true label.

There are no fixed standards for canned goods, though the canner and the trade do recognize and describe certain qualities in jobbing, and prices are made accordingly. The consumer has not been educated to know these differences. The labels usually carry descriptive terms implying superlative quality, as extra select, extra choice, extra fancy, select, choice, fancy, extra standard, and, less commonly, standard. There are too many designations for the same product, and, furthermore, Mr. A's fancy may not be the same as Mr. B's. The grade may not be the same in two consecutive seasons, owing to drought, excess of rain, intense heat, or other cause; neither may it mean the same in different sections of the country in a normal year. In other words, at the present time the grade does not have a fixed character.

Again, when the sirup is one of the factors in grading a product, that fact should be given, though it is not required. A consumer can not go to the grocery and buy peaches in a 40°, 30°, or 20° sirup, though the packers use care in preparing such sirups to use for their different grades. Such designations as heavy, medium, and light sirup are also inadequate. A heavy sirup may mean anything between 35° and 60°, a medium between 20° and 45°, and a light between 10° and 30°, depending on who uses it. These variations are too wide to be carried under such elastic terms. There is no doubt that some fruit packed in light or 20° sirup is just as good as that put up in medium or 30° sirup, but there can be no harm done by giving the exact facts. On general principles, if it is worth while for the packer to select his stock carefully and put up different grades, the consumer should know how to select them.

A can of any food should be as full as it can reasonably be packed and processed without injuring either the quality or appearance of the product. There is such a thing as overfilling as well as underfilling, and one is as much a fault as the other. All foods packed in a liquid or semiliquid condition, or as solids surrounded by liquid, should fill to within one-half inch of the top, and when free liquid is present it should cover the solids. Corn or peas an inch below the top would be a slack fill, even though covered with liquid. The fruits present a more perplexing problem, depending upon the size of the pieces and the degree to which they shrink in the sirup. The very choice large peaches, having only 5 or 6 pieces to the can, will weigh only 18 or 19 ounces and be as full as they can be sealed. A slightly smaller size, of 7 to 9 pieces to the can, will weigh 20 ounces, and for more than 10 pieces the weight will be from 21 to 22 ounces. After they have been cooked in the sirup the pieces will soften, the weight will change, and the fill will not be the same, though in all the amount was as much as could be sealed. If the cans be judged upon weight of the solids alone, the highest grade would be short weight; the quality must also be considered. The presence of only 18 or 19 ounces of low-grade peaches would be manifestly slack filled. Soft berries, like strawberries and raspberries, if filled as full as the can will hold and sirup or water added, will appear only one-third to one-half full of solids upon opening and considerable variation will occur, depending upon their condition. Some foods can be packed so as to give a fairly uniform net weight upon opening, but

with others the volume of solids and its own liquid is a fairer measure. The buyer is entitled to a full can and most packers try to furnish it. The net weights given for several products at the close of the descriptions of processing are intended to represent the minimum; the amount actually obtained should exceed these figures. A lower net weight may be regarded as "slack filled."

USE OF THE TERM "CANNED."

The term "canned" as applied to food products put up in hermetically sealed packages is capable of more than one meaning. Originally it meant any food put up in any container which might be hermetically sealed and the preservation accomplished through sterilization by heat. In commercial use the term "canned" applies only to foods put up in tin containers and sterilized by heat. Under that construction any foods put up in glass or other containers than tin are not rated as commercially canned foods, nor are foods put up in tin in which preservation is accomplished by some means other than heat. Fish cured in brine, pickled, or spiced, but packed in tins, is not canned within this meaning of the term. Fruits preserved with sugar, placed in glass or tin jars, and sealed in vacuum are not canned in the commercial sense. The same is true of smoked meats, such as dried beef, and fish, as smoked herring. In domestic canning glass jars are generally used, and the product is referred to in the home as canned. It is unfortunate that the term should have so many meanings. In the trade it is now common to refer to fruit in glass, sliced bacon and chipped beef in glass or tins, sliced or smoked fish in glass or sardines in tins, and candied fruit in glass.

SPOILAGE.

Spoilage may result from insufficient processing, defective containers, or the use of unfit material. These losses are generally classed under the heads of swells, flat sours, and leaks. Formerly losses were heavy at many factories, but these are becoming less each year, owing to a better knowledge of what is necessary in material, handling and improved appliances. More attention is paid to testing for bacteria, and greater care is taken in obtaining accurate thermometers and gauges, automatic temperature-regulating devices, and time recorders, so that little is left to the judgment of the processor or helper.

Spoilage due to insufficient processing is generally divided into two classes—swells and flat sours. In the former there is generation of gas, causing the ends of the can to become distended; in the latter the content of the can is sour, but there is nothing in the appearance of the can to enable the customer to determine the condition until the can is opened. Swells are generally due to underprocessing good material, while flat sours most often result from giving the regular process to material which has been allowed to stand for some time, such as peas remaining in a load overnight or corn left in a car or in a pile until it begins to heat. The raw material may show no evidence of fermentation on superficial examination, but this condition frequently exists under the conditions just cited. Swells are therefore more likely to be associated with rush operations and flat sours with an overstock or delay in getting at the raw material. It is not intended to give the impression that swells and sours may not occur under other conditions, such as changes in the consistency of the corn, nor that swells may not occur in material which has stood, and sours result from underprocessing, but only to state a general rule.

Swelling or souring may take place shortly after processing or the spoilage may be delayed for weeks or even months. Swelling is more likely to occur and be detected early, while souring is apt to be delayed, though it may occur early. The heat used in

processing may have been insufficient to kill the vegetative forms or spores, but may have injured them to such an extent that time was necessary for recovery and subsequent development. A microscopic examination of the material a few days after processing, or of the incubating cans during a short period, might not show anything wrong. It is only by incubating samples for a number of days that early recognition can be made of some cases of spoilage or possible spoilage. The canner often sends his goods from the factory with full confidence in their condition, and it is not until after they have been in the broker's warehouse or upon the grocer's shelves many weeks or even months that he becomes aware that anything is wrong. The spoilage may amount to only one can to the case, or the percentage may be high; but in either event the goods are rejected with loss.

Spoilage from the use of improper material—i. e., material which has been allowed to stand until fermentation has begun—is generally more or less sour to the smell and taste, but is sterile, the heat of processing having killed the bacteria.

Can leaks may occur along the side, "seam leaks"; at either end, "end leaks"; at the cap, "cap leaks"; at the tip, "tip leaks"; or may be due to defective tin plate. Can making has reached such a point of perfection that manufacturers guarantee all above two to the thousand. These imperfect cans are usually due to the solder not making a perfect union or to defects in crimping or double seaming. With the use of the automatic capping and tipping machines there are fewer leaks than formerly occurred when the work was done by hand; leaks in sanitary cans are generally due to poor adjustment of the rollers. Leakers are recognized, as a rule, by inspection in the hot bath, few getting into the wareroom. Leaks may be very small, even microscopic in size, and, therefore, difficult to detect, or pieces of the can content may be driven into the opening and seal it for the time. Leaks invariably cause swells. A check on spoilage can be kept by placing a few cans from each day's run in a room kept at a high temperature (98°), as these will incubate much more rapidly than if kept in a storeroom. In the laboratory this is done in the ordinary incubator. Since 1903 the writer has used refrigerators in which water tanks are placed in the ice compartment and a heater connected to the outside, the temperature being controlled by a thermo-regulator similar to that used on a chicken incubator. This gives large capacity at low cost and is suitable for small canners. A large chicken incubator has also been used with success.

There are two conditions known to the trade as "springers" and "flippers." A springer is a can the end of which will bulge slightly after a time, but on opening there is found neither gas nor spoilage, though the cans have the appearance of being swells. This condition has been found to be due to overfilling or to packing cold. Such goods when placed in a warm grocery will bulge, owing to the temperature. A flipper is a springer of such mild character that the head may be drawn in by striking the can on a hard object. It is always possible to tell a swell from a springer by the use of a microscope, as in the former there will be large numbers of organisms while in the latter there will be very few.

While a spoiled can of food should never be eaten, the danger of poisoning from fruits and most vegetables is very remote. Ptomain or other poisons may form in meat, milk, and fish, but rarely, if ever, in vegetables.

EFFECT OF HEAT AND COLD.

Canned foods may be injured by an excess of either heat or cold. Some products are injured more than others. The effect of prolonged heating is to cook the contents to a pulp. This is seen at times, in the case of peas and tomatoes in particular, when the cans have been stacked tightly before being fully cooled. The liquor will become cloudy from short heating, thick and heavy from prolonged heating, and the peas

softened and broken if it is continued for a number of days. The writer has seen peas stacked that were warm for three weeks after packing. Tomatoes become soft and pulpy, and often turn a walnut brown if stacked hot and the heat is retained. All fruits become murky and lose their distinctive flavor and odor. Canned foods will stand the high temperature of summer very well, but as far as possible they should not be placed in the hot sun nor kept in a very hot storeroom. The effect of moderate heat is not nearly so marked as might be expected.

Cold seems to have no ill effects upon canned goods unless it goes below the freezing point. Most canned foods will stand a little freezing without appreciable change. Repeated freezing and thawing cause the goods to become flabby and give a flat taste. In all cases the interior of the cans shows a distinct attack upon the tin. With fruits the coating of the cans is made to appear as though it were galvanized. Canned foods will resist a fair degree of heat or cold without serious injury, but continued heat or a very high temperature or repeated freezing and thawing, will cause deterioration in quality.

Foods properly prepared and kept under reasonably good conditions deteriorate very slowly, so that cans carried from one year to another may be as good as, or better than, the latest pack, depending upon the comparative quality of the fresh product used. On general principles, however, it is desirable that a product should not be carried over several seasons. The amount of tin dissolved also increases with time, which is an additional reason for not holding canned goods any longer than is absolutely necessary.

COST OF CANNED FOODS COMPARED WITH FRESH.

In making a comparison of the cost of canned and fresh products of the same kind, a number of factors must be taken into consideration. First, the cost of the raw material and the waste when purchased in the small quantity used in a single meal; second, the cost of labor and preparation used in making it ready for the table. It is obvious that a comparison can not be made for time, as the canned article may be had throughout the year and the fresh for only a limited season, and purchase of a product out of season is usually at a high cost. In making a purchase of either the fresh or canned article, the smaller the quantity, the higher the price; food bought by the single can costs more than if bought by the dozen cans or case, as does the half peck of apples compared with the bushel or barrel. Take, for example, a No. 3 and a No. 10 can of whole apples; the former usually retails for 10 cents and the latter for 25 to 30 cents. Those who can use the latter have a decided advantage, as it will contain between four and five times as much as the former.

There is a vast difference in canned foods, and, as in many other lines of commerce, the cheapest in price is often the most expensive. The can of water-packed tomatoes, the green hard pears, the handful of berries in a pint of water, or poor-quality beans disguised with tomato dressing and offered at a low price, when measured by their food value are the highest. Goods which are strictly standard should give the best food value for the cost. Peas, corn, beans, and tomatoes which are good field run, but which lack the uniformity and niceties which are necessary for the fancy article, will have all the nutritive properties, and be just as palatable, but cost several cents less per dozen. There is much that is pure fad in the purchase of canned foods; the asparagus must be white and the fewest possible stalks in a can; the green is just as good and a medium number of stalks furnish a more edible product. The little peas are, naturally, the costly ones, for less than 5 per cent are of that kind; the large ones are the better flavored and more nutritious, and one-third the cost. Similar examples might be cited of a number of other products. Canned foods should be purchased by the dozen or case, straight or in mixed lots, rather than by single cans.

EXTENT OF THE CANNING INDUSTRY IN THE UNITED STATES.[1]

Quantity and value of foods canned, 1899, 1904, 1909.

Product.	1909		1904		1899	
	Cases.	Value.	Cases.	Value.	Cases.	Value.
Vegetables	32,752,469	$51,568,914	29,597,616	$45,610,993	19,323,730	$28,734,598
Tomatoes	12,909,986	18,747,941	9,411,084	14,020,846	8,700,538	13,666,560
Corn	7,451,265	10,332,136	11,209,597	15,952,386	6,336,984	8,191,383
Peas	5,901,703	10,247,363	4,694,492	7,928,791	2,543,722	4,465,673
Beans	3,392,864	6,013,098	2,588,015	4,133,810	1,493,517	2,025,123
Asparagus	228,559	1,975,775	.....	.....	.....	.....
Pumpkin	440,303	576,043	246,557	346,497	138,078	202,404
Sweet potatoes	347,286	531,651	192,997	284,385	83,526	124,245
All other	2,080,503	3,144,907	1,236,874	2,944,287	27,365	59,210
Fruits	5,518,999	12,938,474	4,628,211	11,722,979	4,467,817	11,311,062
Peaches	1,484,808	3,753,698	1,304,867	3,902,441	1,449,356	4,283,165
Apples	1,205,742	1,898,720	490,341	738,013	645,762	1,125,119
Apricots	630,185	1,825,311	539,815	1,641,919	531,648	1,538,252
Pears	637,782	1,833,214	789,120	2,192,910	672,485	2,188,201
Berries	815,851	1,754,927	489,037	1,058,659	600,419	1,092,975
Cherries	390,351	1,019,013	319,350	825,522	114,367	307,788
All others	354,280	853,591	695,111	1,363,515	453,780	730,562
	Pounds.		*Pounds.*		*Pounds.*	
Fish and oysters	235,418,713	17,573,311	207,077,976	13,531,786	.....	12,868,572
Salmon	99,831,528	8,723,565	48,128,926	4,251,387	62,652,792	5,679,324
Sardines	90,694,284	4,931,831	87,224,524	4,380,498	44,951,244	4,212,351
Oysters	28,192,392	2,443,101	59,249,043	3,799,412	.....	2,054,800
All other	16,700,509	1,474,814	12,475,483	1,100,489	9,625,825	922,097
Condensed milk	494,796,544	33,563,129	308,485,182	20,149,282	186,921,787	11,888,792
Sweetened	214,518,310	17,345,278	198,355,189	13,478,376	.....	.....
Unsweetened	280,278,234	16,217,851	110,129,993	6,670,906	.....	.....
Meats	121,376,837	15,345,543	.....	16,144,665	112,443,021	9,166,931
Other products, soups, specialties, preserves, and pickles	.....	43,030,529	.....	35,272,585	.....	35,725,257

PACKING SEASONS.[2]

Seasons for packing various products in the different States.

State.	Apples.	Apricots.	Asparagus.	Baked beans.
Arkansas	July 23 to Aug. 15	.....	.....	.....
California	Sept. 17 to Nov. 26	June 1 to Aug. 10	Mar. 25 to July 1	.....
Colorado	Sept. 1 to Oct. 31	.....	May 1 to June 30	.....
Connecticut	Sept. 30 to Oct. 30	.....	.....	.....
Delaware	Sept. 20 to Oct. 10	.....	.....	.....
Georgia	Aug. 1 to Sept. 1	.....	.....	.....
Illinois	Aug. 10 to Nov. 15	.....	May 20 to June 20	Jan. to Dec.
Indiana	Oct. 1 to Nov. 15	.....	.....	Jan. to Dec.
Kansas	Oct. 1 to Oct. 28	.....	.....	.....
Maryland	Oct. 1 to Nov. 1	.....	.....	Jan. to Dec.
Massachusetts	.....	.....	.....	Jan. to Dec.
Michigan	Aug. 1 to Nov. 1	.....	.....	Jan. to Dec.
Minnesota	Aug. 15	.....	.....	Jan. to Dec.
Missouri	Sept. 18 to Oct. 17	.....	.....	.....
Nebraska	Sept. 1 to Nov. 1	.....	.....	.....
New Jersey	.....	.....	May 13 to July 1	Jan. to Dec.
New Mexico	Oct. 15 to Dec. 25	Aug. 1 to Aug. 15	.....	.....
New York	Sept. 15 to Dec. 31	July 20 to Aug. 20	May 10 to July 15	Jan. to Dec.
Ohio	Oct. 1 to Nov. 20	.....	.....	.....
Oregon	Aug. 25 to Dec. 1	.....	.....	.....
Pennsylvania	July 1 to Dec. 1	.....	.....	.....
Tennessee	Oct. to Nov.	.....	Apr. 15 to May 10	.....
Utah	July 25 to Dec. 1	July 24 to Oct. 1	Apr. 26 to June 10	.....
Virginia	Sept. 1 to Oct. 20	.....	.....	.....
Washington	Aug. 15 to Dec. 10	July 1 to Aug. 1	.....	.....

[1] From Thirteenth Census of the United States, 1910, volume X, Manufactures.
[2] From reports of canners.

Seasons for packing various products in the different States—Continued.

State.	String beans.	Beets.	Blackberries.	Cherries.
Arkansas			July 1 to Aug. 15	
California	Aug. 1 to Sept. 15		May 29 to Sept. 10	May 15 to July 28
Colorado				June 15 to Aug. 1
Delaware			July 1 to July 20	
Georgia	July 1 to Aug. 1		June 10 to June 20	
Illinois				June 15 to July 15
Indiana	June 1 to Oct. 1			
Kansas	June 8 to July 27			
Maryland	July 10 to Aug. 20		July 4 to July 20	June 8 to June 30
Michigan	June 10 to Sept. 15	July 1 to Oct. 1	July 15 to Aug. 24	June 25 to Aug. 10
Minnesota		June 20 to Oct. 22		
Nebraska	June 10 to July 15		July 1	July 1
New Jersey		June 15 to July 25	July 5 to July 15	June 9 to June 20
New York	July 1 to Oct. 28	July 15 to Nov. 25	July 23 to Sept. 1	June 20 to Aug. 1
Ohio	July 1 to Sept. 30	June 25 to Nov. 10	July 1 to Aug. 10	June 1 to June 30
Oregon	July 15 to Oct. 15		July 15 to Oct. 15	June 10 to Aug. 20
Pennsylvania	July 10 to Oct. 15	Aug. 1 to Sept. 15		Aug. 17 to Oct. 1
Tennessee	June 15 to July 10		June 15 to July 5	May 25 to June 25
Utah	June 30 to Oct. 1			July 1 to Aug. 15
Vermont	July 20 to Aug. 20			
Virginia	July 20 to Aug. 30		July 1 to Aug. 1	June 1 to June 30
Washington				June 25 to July 20
Wisconsin	July 10 to Aug. 25			

State.	Corn.	Currants.	Gooseberries.	Grapes.
California		June 5 to June 30	May 21 to June 1	Aug. 1 to Dec. 1
Colorado		June 15 to Aug 30	May 15 to June 30	
Delaware	July 15 to Sept. 15			
Illinois	Aug. 1 to Oct. 1			
Indiana	Aug. 1 to Oct. 15			
Iowa	Aug. 5 to Oct. 1			
Kansas	July 24 to Sept. 15			
Maine	Aug. 20 to Sept. 20			
Maryland	Aug. 1 to Oct. 20			
Massachusetts				
Michigan	Sept. 1 to Oct. 1	July 1 to Aug. 1	June 20 to July 30	
Minnesota	Aug. 1 to Oct. 1		June 1 to July 1	
Missouri	Aug. 10 to Sept. 27			
Nebraska	Aug. 1 to Oct. 1			
New Hampshire	Aug. 25 to Sept. 20			
New Mexico				Sept. 15 to Oct. 1
New York	July 26 to Oct. 17	July 1 to Aug. 5	June 20 to Aug. 1	
Ohio	Aug. 1 to Nov. 1		June 10 to June 20	
Oregon		June 1 to July 15	June 1 to July 10	Sept. 15 to Oct. 30
Pennsylvania	Aug. 15 to Oct. 15			
Utah			June 15 to July 10	
Vermont	Aug. 25 to Sept. 25			
Virginia	July 20 to Oct. 20		June 1 to June 30	
Wisconsin	Aug. 10 to Oct. 10			

State.	Hominy.	Lima beans.	Okra.	Peaches.
Alabama				July 15 to Aug. 15
Arkansas				Aug. 1 to Oct. 1
California				June 25 to Oct. 25
Colorado	Jan. to Dec.			
Delaware			Aug. 15 to Sept. 15	July 25 to Aug. 15
Florida			June 1 to July 1	
Georgia				June 20 to July 25
Illinois	Jan. to Dec.			Sept. 10 to Oct. 10
Indiana	Jan. to Dec.			
Louisiana			July 20 to Aug. 30	
Maryland		Aug. 1 to Sept. 1	Aug. 10 to Aug. 30	
Michigan		Aug. 15 to Sept. 20		Sept. 11 to Nov. 1
Missouri				Aug. 11 to Sept. 5
Nebraska				Sept. 10 to Oct. 10
New Jersey		Aug. 1 to Sept. 30	June 1 to Sept. 20	
New Mexico				Sept. 1 to Oct. 1
New York	Jan. to Dec.	July 29 to Oct. 15		Aug. 25 to Oct. 20
Ohio	Jan. to Dec.	Aug. 10 to Oct. 30		Aug. 10 to Aug. 31
Oregon				Aug. 10 to Oct. 10
Pennsylvania	Jan. to Dec.	Aug. 15 to Sept. 15		
Tennessee				July 20 to Aug. 20
Texas				June 15 to Sept. 1
Utah				Sept. 6 to Oct. 6
Virginia				Aug. 1 to Oct. 15
Washington				July 15 to Sept. 30

Seasons for packing various products in the different States—Continued.

State.	Peas.	Pears.	Pineapples.	Plums.
California	May 1 to June 20	July 1 to Oct. 27		July 1 to Sept. 10
Colorado		June 15 to Aug. 15		
Connecticut			Sept. 30 to Oct. 20	
Delaware	June 1 to June 30	Sept. 20 to Oct. 20		
Florida			May 15 to Sept. 1	
Georgia	June 1 to June 15			
Illinois	June 14 to July 14			
Indiana	May 26 to July 15			
Kansas	June 5 to June 30			
Maryland	June 5 to July 1	Sept. 1 to Nov. 1		
Massachusetts		Oct. 1 to Nov. 1	June 2 to June 10	
Michigan		Aug. 20 to Nov. 5		
Minnesota	June 15 to Aug. 1			
New Jersey	June 6 to June 25	Oct 10 to Nov. 15		
New Mexico		Sept. 15 to Oct. 15		
New York	June 15 to Aug. 31	Aug. 25 to Nov. 9	May 14 to June 25	Aug. 5 to Sept. 20
Ohio	June 1 to July 10			
Oregon	June 1 to July 20	Aug. 25 to Oct. 10		
Tennessee		July 25 to Oct. 25		
Texas	July 1 to Sept. 1	July 15 to Aug. 30		
Utah	June 10 to July 25	Aug. 26 to Sept. 18		
Virginia	May 20 to June 19	Sept. 1 to Oct. 15		
Washington		Aug. 1 to Oct. 15		
Wisconsin	June 15 to Aug. 28			

State.	Pumpkin.	Quince.	Raspberries.	Rhubarb.
Arkansas	Oct. 15 to Nov. 15			
California	Sept. 15 to Jan. 1	Sept. 6 to Nov. 2	June 28 to Oct. 6	
Colorado	Oct. 1 to Dec. 31			May 15 to June 30
Delaware	Oct. 10 to Oct. 20			
Illinois	Aug. 10 to Nov. 20			
Indiana	Oct. 1 to Nov. 20			
Kansas	Oct. 1 to Nov. 24			
Maryland	Sept. 10 to Oct. 10			
Massachusetts		Oct. 1	July 3 to July 18	
Michigan	Oct. 1 to Dec. 25		July 1 to July 15	July 1 to Aug. 1
Minnesota	Sept. 25 to Nov. 7		Sept. 1 to Oct. 1	June 1 to July 1
Missouri	Sept. 15 to Nov. 15			
Nebraska	Oct. 1 to Nov. 1			June 1 to July 1
New Jersey	Sept. 1 to Nov. 1			
New Mexico	Nov. 1 to Nov. 15			
New York	Sept. 10 to Nov. 13	Oct. 1 to Dec. 1	June 25 to Aug. 15	May 15 to July 1
Ohio	Sept. 25 to Nov. 24		June 7 to July 20	
Oregon	Aug. 15 to Dec. 1		June 15 to July 15	June 1 to July 30
Pennsylvania	Sept. 20 to Nov. 30			
Tennessee	Oct. 15 to Nov. 15		June 15 to July 8	
Utah	Oct. 15 to Nov. 15		July 15 to July 30	May 15 to June 30
Virginia		Sept. 1 to Sept. 30	June 1 to June 30	
Wisconsin	Oct. 10 to Nov. 12			

State.	Sauerkraut.	Spinach.	Squash.	Strawberries.
California			Nov. 1 to Jan. 1	June 16 to Sept. 28
Colorado	Oct. 15 to Mar. 31			May 30 to June 30
Connecticut			Sept. 30 to Nov. 20	
Delaware			Oct. 10 to Oct. 20	June 6 to June 30
Georgia	Sept. 1 to Dec. 30			
Illinois	Sept. to Nov.			
Indiana	Sept. 1 to Apr. 1			
Kansas	Sept. 1 to Dec. 1		Nov. 2 to Nov. 24	
Maryland				June 20 to July 4
Massachusetts				June 1 to July 8
Michigan				June 15 to July 15
Minnesota	Dec. 1 to Jan. 1	June 15 to July 1		
Nebraska		June 1	Oct. to Nov.	
New Jersey		Sept. 15 to June 25	Sept. 20 to Oct. 30	June 1 to June 21
New Mexico	Dec. 26 to Feb. 1			
New York		June 10 to July 1	Sept. 15 to Dec. 1	May 30 to July 15
Ohio	Sept. 11 to Nov. 15	May 25 to Nov. 30	Oct. 1 to Nov. 10	May 25 to June 30
Oregon			Sept. 15 to Dec. 1	June 6 to July 20
Tennessee				June 1
Texas				July 1 to Sept. 1
Utah	Aug. 1 to Oct. 20		Oct. 1	

Seasons for packing various products in different States—Continued.

State.	Succotash.	Sweet potatoes.	Tomatoes.
Alabama		Nov. 1 to Dec. 1	Aug. 1 to Oct. 10
Arkansas			Aug. 1 to Oct. 1
California			Aug. 8 to Dec. 1
Colorado			Aug. 20 to Oct. 1
Connecticut			Aug. 15 to Nov. 1
Delaware		Oct. 6 to Oct. 18	Aug. 1 to Oct. 20
Georgia		Aug. 1 to Sept. 1	Aug. 10 to Oct. 1
Illinois			Aug. 10 to Oct. 20
Indiana			Aug. 1 to Nov. 1
Iowa			Aug. 10 to Oct. 15
Kansas		Oct. 8 to Oct. 26	July 27 to Oct. 5
Kentucky			Aug. 1 to Sept.
Maryland	Aug.	Oct. 10 to Nov. 1	Aug. 20 to Oct. 20
Massachusetts			Sept. 1 to Oct. 1
Michigan			Aug. 15 to Nov. 1
Minnesota			Sept. 1 to Oct. 10
Mississippi			July 20 to Oct. 30
Missouri			Aug. 20 to Oct. 1
Nebraska	Sept. 1		Sept. 1 to Oct. 5
New Jersey		Oct. 1 to Nov. 1	Aug. 15 to Oct. 25
New Mexico			Aug. 1 to Nov. 1
New York	Aug. 15 to Oct. 15		Aug. 1 to Nov. 2
Ohio	Aug. 1 to Sept. 15		Aug. 10 to Nov. 15
Oregon			Sept. 1 to Nov. 1
Pennsylvania	Feb. 15 to Sept. 15		Aug. 1 to Nov. 1
Tennessee		Oct. to Nov.	July 15 to Oct. 15
Texas		July 1 to Sept. 1	June 15 to Sept. 1
Utah			Aug. 7 to Oct. 30
Virginia			Aug. 15 to Oct. 15
West Virginia			Aug. 1 to Nov. 7
Wisconsin			Aug. 15 to Oct. 1

EXPERIMENTAL WORK.

During the season of 1912 an experimental canning laboratory was established in San Francisco for the purpose of studying the problems connected with the canning of fruits. It was located within two blocks of the great fruit market, so that continuous observation could be made of the raw products as they were delivered to the commercial canneries, where the conditions are not very different from those in smaller places. It was also near the food and drug inspection laboratory, thus expediting cooperative work.

The equipment consisted of the usual cookers and machinery found in a first-class canning and preserving factory, only of a smaller size. An eight-horsepower, high-pressure boiler furnished the steam, a five-horsepower motor and a half-horsepower motor the power. The outfit included an open sterilizer, a 22-inch by 36-inch vertical retort fitted for steam or water, with positive circulation, a similar horizontal retort equipped with an agitator, a coil dryer, iron, copper, and aluminum jacketed kettles or preserving pans, an inside enameled iron vacuum pan, a copper vacuum pan, a pasteurizer, and an exhaust box. Two types of closing machines were used, one adjustable for size, in which the can turned, and the other fixed, in which the can remained stationary while being sealed. A vacuum sealing machine was installed for glass jars. A vacuum pump, pressure blower, bottle and can-washing machine, hydraulic press, centrifugal clarifier, bottle filler, cooking coils, peeler, slicer, pulper, and other small apparatus were provided for work in which they might be necessary. Much of the apparatus was so constructed that it could be used for a variety of purposes. The object was to make the dozen or the case the unit of experiments in the regular canning, and from 1 to 10 gallons the unit for the batch in kettle cooking, ro that complete records might be kept and the experiment yet be under factory conditions.

The general plan of the experimental work in canning involved the use of underripe, prime ripe, overripe, and spoiled fruits of all the varieties canned, to deter-

mine the appearance and effect upon the finished product. The proper fill for the can was obtained by varying the weight from below the normal to one in which more or less crushing was apparent, or by using 450, 500, 550, and 600 grams in a No. 2½ can. The effect of the sirup upon the fruits was observed by using water and 10°, 20°, 30°, 40°, 50°, and 60° sirups. The time of processing varied from 5 to 25 minutes. Nearly all experiments were divided into two lots, one cooled and one not cooled, to note the effect of this treatment. The time of the exhaust was varied on some lines. Two grades of cans were used in a majority of the experiments, the plain tin and the inside-lacquered, both from usual stock as supplied to packers.

These experiments involved the preparation of fruit, weighing it into the cans, and making sirups to exact degrees for more than 5,000 cans. In addition, cooperative work was carried on with a number of canneries in the testing of sirups and in the examination of the pack, the total number of cans from this source examined being about 600. A record of the experimental pack and that of the product sent in involved the weighing of each can as to contents, solids, and sirup, passing upon the commercial grading and the effect upon the can, and in very many instances a chemical examination of the sirup for solids, sugar, and acidity. A microscopical examination was also made to determine the number of organisms present. Each experimental lot was examined shortly after packing and again later to determine the effect of standing. Direct shipments of mixed lots from the experimental pack and also from commercial packs were made by express and by freight direct from San Francisco to La Fayette, Ind., and one by sea from San Francisco to New York and then overland to La Fayette, in order to note the effect of shipments.

During the following winter experiments were conducted to observe the effects of freezing and thawing.

The work was continued in 1913, using some products omitted in 1912, repeating experiments that seemed desirable, and increasing the scope along the lines showing greatest promise of good results. The work still in progress is a determination of the changes effected by standing, the effect of shipping, and of freezing and thawing. The results as far as the work has progressed have been summarized in simple terms under the respective fruits. The purpose has been to eliminate everything that is too technical to be easily understood by the packer or the general public.

In the examination of the details of the experimental work it may appear to those whose experience has been limited to laboratory operations that the individual variations are greater than they should be. For example, the gross weight of individual cans in a set of a dozen or in a case may vary as much as 20 to 50 grams when the fruit has been weighed in and sirup added to make a uniform fill. A part of this variation is due to the effect of exhausting and to the action of the capping machine. Some fruit expands more in exhausting and floats high in the can; consequently it will be thrown off if struck quickly by the plunger preparatory to capping or an excessive amount of sirup may be forced out. In the type of machine in which the can spins while being crimped more or less sirup will be thrown out, depending upon how free it is at the top. The object throughout all the experiments has been to duplicate factory operations and not to attempt to make mathematical standards. The variations indicate the advisability of taking the contents of at least three cans for a composite sample in food analyses or examinations and not to depend upon the contents of one can. They also show that canners can not deliver fixed net weights in cans with the present available methods. Unless otherwise noted the can used is the regular No. 2½.

The method used in draining the fruit was to cut all cans around the outside at the top, leaving the end attached at one point. The end was held in place and the liquid drained by inverting and slowly rotating until all free liquid escaped. This method, which can be used at any place, gives quite uniform results and is more

nearly accurate than one which involves pouring the liquid upon a screen. With such products as tomatoes, which are cooked until they are broken to pieces or mushy, the weight of solids will be a little higher than if a screen were used, but for products which are whole or in separate pieces there will be little difference between the two methods.

The acidity is uniformly expressed in terms calculated as citric acid. The results of the experiments apply only to California products, as in structure and behavior those fruits differ so much from those grown in other sections of the United States that inferences of similar behavior would not be warranted. Practically all the chemical work reported was performed by F. D. Merrill in the San Francisco Food and Drug Inspection Laboratory, and the last analysis by A. W. Broomell in the Bureau of Chemistry.

DETAILED CONSIDERATION OF THE VARIOUS PRODUCTS.

FRUITS.

General Discussion.

The first essential is that the fruits be harvested when in prime condition, handled with care to prevent injury or bruising, and conveyed with speed from the tree or vine to the factory. For canning purposes it is not necessary, and may not be desirable, that all fruits be as far advanced or as soft as for eating, but they should be ripe, with the flavor characteristic of the ripe fruit. They should not be so far advanced that they will not withstand the ordinary cooking necessary for sterilization without breaking to pieces. The prime condition for canning is that state of maturity in which the flavor and other characteristic qualities have been developed to the maximum and may be retained during sterilization.

Bruised or damaged fruit can not be made attractive, and its use involves heavy waste. The proper handling of the fruit is therefore very important. Apricots, peaches, pears, etc., should be handled in shallow boxes which will not hold more than a bushel and will not admit of more than three or four layers of fruit. The top should be protected with cleats, so that one box can be set upon another without touching the fruit, thus insuring some ventilation. The small fruits—strawberries, raspberries, blackberries, and loganberries—are handled almost exclusively in chests, which are illustrated in detail in Plate II. The California packers have developed this part of the business to a higher degree of perfection than those in any other section of the country. The conical basket used in handling tomatoes in the East should be abolished. The depth is too great and the shape such that the weight of superimposed fruit wedges the lower layers tightly together, causing crushing, rotting, and excessive waste. The baskets are weak, do not stack without bruising or cutting the fruit, and easily become disarranged or broken in shipping.

Rapid transfer of the fruit to the factory after it has been picked is very essential. Deterioration in flavor and weight begins early; conditions favor the growth of organisms, and bacteria, yeast, and mold may develop wherever the fruits press together or the skins are broken. Delicate fruits, such as berries, if picked in the morning should be at the factory in the afternoon, or if picked in the evening should be delivered in the morning. Fruits with hard skins will last much longer, but the rule with all should be quick action. One of the disadvantages of a factory located in a city is the delay in receiving fruit promptly; dependence upon the surplus of the fresh fruit market is hazardous.

One source of trouble and a cause of spoilage of much fruit is contamination from sour and moldy boxes. When a box is used several times it becomes permanently infected and a cause of infection by spoliage organisms. This can be controlled without much difficulty by having a tight room in which the worst boxes are placed

after they are emptied, with steam turned on to saturate the atmosphere and sulphur burned or sulphurous acid gas liberated to act as a disinfectant. This does not require a large place, much time, or expense.

To test the effect of box infection upon spoilage, strawberries, loganberries, and raspberries were obtained and each lot divided into two parts. One part was placed in clean new veneer boxes and the second part in boxes which had been used and become slightly moldy. They were held under the same conditions for 48 hours, at the end of which time each berry was examined. Twenty per cent of those in the new boxes showed some mold, while 80 per cent of those in the used boxes showed infection. When tomatoes cost $10 a ton, fruits from $20 to $50 a ton, and berries from $50 to $80 a ton, the importance of reducing the waste from packing to the minimum becomes obvious.

The standard California berry case is made of good lumber and in a careful manner so that it may be used for shipping purposes for several seasons. The length is 41 inches, width 17½ inches, and height 16 inches. The interior is divided by three partitions into four compartments, each with five drawers. The drawer is 15½ inches long, 8¾ inches wide, and 2 inches deep. A hinged door closes over the front of the drawers so that they remain securely in place. The material used in the chest is three-quarters of an inch thick, the partitions being 1 inch. The veneer boxes used are 4 by 5 by 1½ inches or 7 by 8 by 1½ inches.

The standard fruit box has the length 24 inches, width 15 inches, and height 9 inches. The material is three-fourths of an inch thick and has stacking guards 1½ inches wide across the ends.

Fruits are the easiest of all articles to can, as subjecting them to a boiling temperature for a short time is sufficient for sterilization in nearly all cases. Formerly it was the practice to pack almost all fruit in No. 3 cans, but recently many changes have been made. Eastern fruits, particularly those of high grade, are packed very largely in the No. 2, while in California the No. 2½ open-top has wholly displaced the No. 3 solder-top cans. The quantity of fruit placed in the No. 2½ open-top can is only slightly less than that held by the old style No. 3. The No. 2 is coming into use on the coast, also the No. 1 flat or picnic size for whole or large fruit, and the No. 1 tall for sliced stock. The picnic size has the same diameter as the No. 2½ but is shorter, being well designed for a small service. A new No. 2 having the same diameter as the No. 2½ has made its appearance. These changes are evidence that the packer realizes the importance of having containers better adapted to packing his products in an attractive form and of having sizes better suited to the needs of the consumer.

In canning fruits the general practice is to fill the cans as level full as is possible without crushing or mashing, and then add the necessary hot sirup to fill the interstices. The amount of fruit used depends upon the variety, the size of pieces, and the state of maturity. When seven or eight large pieces of peaches or pears fill a can, the spaces between them are much greater than when 20 pieces are used. Under such conditions it is obvious that weight alone is not the proper standard for passing judgment, as in the former case the can may be full and contain only 17 or 18 ounces, while in the latter there may be 20 ounces or more. In medium-sized fruits, as peaches, pears, and apricots, a difference of 1 or 2 ounces may easily result from layering the fruits in the cans. This is done with display material in glass, but since it can not be done by machinery that refinement is not used in packing in tin, though some arranging is done on the better grades to insure a fair degree of uniformity in the pack. Such fruits as strawberries and raspberries will differ to the extent of 2 ounces in the packing weight, 20 ounces or more of raspberries being easily packed in a No. 2½ can, while it might require much crushing of strawberries to attain that result. Each product should be packed closely and according to its individual characteristics and not according to a set rule for a whole line.

Peaches in Standard Fruit Boxes being Loaded into a Car.

THE UPPER FIGURE SHOWS DRAWERS AND CHESTS FOR SHIPPING BERRIES. THE LOWER FIGURE SHOWS THE METHOD OF HANDLING EMPTY FRUIT BOXES.

THE WRONG WAY: STORAGE YARD AND TOMATO-PEELING SHED, WHERE TOMATOES ARE EXPOSED TO THE HEAT OF THE SUN AND TO EARLY SPOILAGE.

The cut-out weight of fruit will not be the same as the weight of fruit introduced, but will vary according to the structure and state of maturity of the fruit and the method of handling. A fruit which is very succulent and has little supporting tissue, such as strawberries or raspberries, undergoes heavy shrinkage, depending upon the strength of the sirup used, while a pear, with its stronger supporting tissue, will suffer little change. The sugar of the sirup unites with the plant juice, and abstracts a part of the water. The fruit loses in weight, the sirup gaining a proportionate amount. The changes in weight, however, are not as great as those in volume. The most marked decrease in the weight of fruit is apparent shortly after processing, after which a gradual increase takes place until the sugar in the fruit and that in the sirup become equalized. Just how much time is required for this process has not been determined.

As an illustration of the changes going on within the can, the analysis of two lots of blackberries and the weights of apricots, cherries, peaches, and pears are given. The first analysis of the blackberries was made the day after canning, the second 70 days later. The weights on the other fruits were taken for the first reading within 30 days after packing and for the second from 120 to 180 days later. The cans were not selected to have a definite and uniform weight, so that the gross weight varies somewhat, but the change in each case goes on in one direction, as is shown in the table. The average given is for seven samples in each set.

The effect of standing on changes in composition of blackberries and on the weight of solids and sirup of apricots, cherries, peaches, and pears.

Kind of fruit and time of standing.	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity (as citric acid).
Blackberries, 50° sirup:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
1 day	1,050	910	384	526	31.6	9.93	18.27	0.42
70 days	1,049	909	428	481	29.1	12.35	13.71	.56
Apricots, standard:								
First reading	992	852	465	387	15.6			
Second reading	1,010	870	553	307	17.7			
Apricots, extra standard:								
First reading	1,023	883	465	418	20.7			
Second reading	1,013	873	563	337	20.0			
Cherries, standard:								
First reading	1,018	875	545	333	18.1			
Second reading	1,013	873	570	303	17.5			
Cherries, extra standard:								
First reading	1,030	890	507	383	21.5			
Second reading	1,027	887	542	345	21.0			
Peaches, standard:								
First reading	977	837	506	331	16.1			
Second reading	979	839	569	277	16.5			
Peaches, extra standard:								
First reading	1,010	870	503	367	22.2			
Second reading	1,025	885	605	280	22.3			
Pears, extra standard:								
First reading	982	842	532	310	16.6			
Second reading	988	848	565	283	17.8			

Unfortunately, systematic data are not available concerning the rate or extent of the changes. Some of the better packers recognize these changes in a practical way by refusing to send out samples of fruits sooner than 30 or 40 days after packing, stating that at first neither the appearance nor the flavor is what it will be after standing. While a heavy sirup tends to soften and shrink ripe fruit, it has less effect on that which is slightly underripe or green. The underripe fruit gives sharper, cleaner-cut edges, especially with peaches, pears, and apricots, and less color and fewer particles of fruit in the sirup. The tendency to exaggerate these points of appearance accounts for the use of some material which would be improved in flavor if it were allowed to mature

more fully. The figures in the table also indicate why the figures which are given by the packer may not agree with those obtained by a purchaser or a food official. The packer does his testing soon after the pack is made and the broker or customer at a later date.

The rate of heating soft fruits has a marked effect upon the fill. This is shown very clearly in the packing of cherries. When a hot 50° or 60° sirup is placed upon Royal Anne cherries, exhausted and processed in the usual way, it causes heavy shrinkage and decided toughening. If the same sirup were applied partly cooled and were then gradually heated to the boiling point, taking from 45 to 60 minutes, there would be very little shrinkage or toughening of the fruit. The same principle holds true with other fruits, much of the shrinkage being due to the rapidity with which the work is done.

EFFECT OF SHIPPING.

One lot of fruit was sent from San Francisco to La Fayette, Ind., by express; another by freight directly, and a third by freight via Panama and New York, while a fourth was held as a control. These lots contained apricots, blackberries, grapes, peaches, plums (green gage and yellow egg), and apples. The grades were water, standard, and extra standard for each line. Later the experimental pack was shipped to Washington. Fruits having a fairly strong skin, such as grapes and green gage plums, were affected to a slight extent by shipping, while very soft fruits, such as loganberries and yellow egg plums, suffered considerable mashing, so that upon draining the solids occupied less space and weighed less than in the control lots. The loss in weight on solids varied from 15 to 90 grams (one-half to 3 ounces) on the very soft fruits, the heaviest loss always being in water or sirup under 30° Balling.

EFFECT OF TIME OF HOLDING.

There seems to be a general impression that canned foods deteriorate with age, but upon this point little direct experimental evidence appears. In these experiments some products have shown deterioration by losing color and flavor and becoming more or less flabby. There is nothing to indicate that they have been injuriously affected, but they are lacking in attractiveness, which, after all, is an element of value in food. Other products have shown a marked improvement on standing, particularly in the development of a fine flavor. Just how much of these changes is due to time has not been determined. Without doubt the process applied, the practice in regard to cooling, whether promptly or not at all, and the temperature at which the foods are held in storage are much more active forces in causing change, and it would require a special set of experiments to determine the effect of time alone. The most marked improvement in flavor was noted in apricots packed at a low temperature, with very appreciable improvement in peaches, blackberries, and strawberries packed at a low temperature and held for two years. A sirup of 20° or more served in some cases as a protection in holding the fruit in a whole condition. The heavy sirup was sufficiently viscous to prevent injury from jarring. The water-packed fruits showed more breaking, increased turbidity of the liquor, and a tendency to settle together more than those with a medium or heavy sirup. The packer seldom has an opportunity to see his product after it has traveled a long distance, and would probably be greatly surprised at the condition of his lower grades as compared with their appearance when they leave the warehouse.

SIRUP.

A proper sirup is a necessity in the packing of most fruits, and has become as much an essential of the grade as the size and quality of the pieces. The sirup may vary from very light to very heavy, or between 10° and 60° on the Balling scale. By common consent the sirups are generally made to be 10°, 20°, 30°, 40°, 50°, or 60° Balling,

though this grading is not strictly followed by all packers. Some use about 2° less and others use 15°, 25°, and 55° to replace 20°, 30°, and 60°. The degree of sirup is arbitrary with the packer and is not indicated upon the label, so that the consumer has nothing as a guide. He can not select a sweet or a tart grade from the information given. The strength of the sirup to be used depends upon the acidity of the fruit, the quantity of fruit, and the flavor desired. Flavor should be the real guide, as much better results can be obtained in developing a good flavor by cooking the sugar into the fruit in canning than by any subsequent addition. With a light weight of fruit in a can, a lighter weight sirup will give the same result on the cut-out as would be given by a heavier sirup on a full pack. Full-weight packing therefore demands not only more fruit than is sometimes found but a correspondingly heavier sirup to secure the same flavor.

The importance of having good, uniform, clean sirup is not fully appreciated by canners. The water used is sometimes unsuitable, being charged with iron or carbonates, which produce a more or less cloudy precipitate and consequent injury to the appearance of the food. The method employed in making the sirup may also cause variation in the readings; correction may not be made for temperature; and cheap and inaccurate hydrometers may be used. The addition of a given quantity of sugar to a tank of water, followed by heating, does not insure uniform distribution, though the sugar may be dissolved. Without thoroughly mixing the contents, a sample taken for a test may give an erroneous reading. All instruments are graduated at a standard temperature, so that correction in the readings is necessary for any variation from the given temperature, a precaution which is frequently neglected. The usual Balling instrument is easily affected by heat, and frequent dipping in and out of hot solutions will cause it to lose its accuracy.

That more might be known concerning the condition of the sirup in the factories, an invitation was issued to 20 canners to send in samples from time to time during the season. A few kindly cooperated. The sample was drawn as it was being delivered to cans of fruit, was processed, and then forwarded to the laboratory. It was taken without the knowledge of the sirup maker, and was thus clearly representative of the sirup in use. The following table shows the results:

Examination of sirups in use at canneries.

Standard.	Highest found.	Lowest found.	Average.	Number of samples.		
				Total.	Above standard.	Below standard.
° *Balling.*	° *Balling.*	° *Balling.*	° *Balling.*			
60	60.9	60.1	60.6	4	4	0
55	57	37	49.5	9	3	5
50	52	49.6	50.2	3	1	2
40	43.9	25.7	37	37	11	24
30	34.2	18.4	28.8	51	14	31
20	26.5	12.6	21.6	47	15	28
15	21	10.3	14.8	22	8	12
10	21.5	6.1	10.3	43	21	20
				216	77	122

This table itself is evidence that the sirup is not made with sufficient care, or that simpler methods must be used to obtain the correct result. Examination was also made as to color, presence of flocculi or precipitate, effect upon the can, trace of oil, and number of microorganisms. Some factories had a uniformly white, clean sirup, while others had all shades, varying from white to a deep reddish or straw color, depending upon the source of the water supply and its effect upon the can. With clear, soft, or distilled water there was very little attack upon the can, while

with some of the sirups there was a decided rusting, particularly at the ends and along the side seam. When fruit is present the color is not so apparent, either in the sirup or as a deposit on the can. A trace of oil may come from the can, but its presence is more often significant of the use of the overflow from a siruping machine and its contamination there. Large numbers of organisms are usually associated with sirup remaining in the tank overnight or with pipes which have been unused for a rather long period. More organisms are always found with the use of a dip box than with a siruping machine.

From the observations made at factories and as a result of experiments, it is believed that more uniform results can be obtained in the making of sirup by using relatively tall and narrow tanks rather than the wide flat form, so that they may be filled to a given height with water and a certain number of pounds of sugar added which will give the degree of sirup desired. The work could be calculated carefully the first time and corrections made on a scale for temperature, so that the chances for making an error would be reduced to the minimum. The tank should be provided with a stirring device to insure the even distribution of the sugar in the water while it is going into solution. The heating should be accomplished by means of a steam coil rather than by the discharge of steam directly into the sirup. All sirup should be filtered through clean Canton flannel to remove any particles that may be introduced in the handling of the sugar.

For a simple factory test upon a sirup, it is suggested that one or two cans of it be processed in the same manner as the food product upon which it is being used and the can cut after standing for two or three days. If made properly it should be clear and clean.

Sirups are tested by means of a hydrometer, or spindle. This instrument consists of a weighted cylinder having a stem. It is made so that it will float at a given height in water at a temperature of 60° F. If the instrument is placed in a liquid heavier than water it will float, but at a different level. Advantage is taken of this fact, the stem being graduated to indicate different weights or densities of liquids. There are four different kinds of hydrometers used by packers, namely, Balling, Brix, Baumé, and specific gravity. There is no difference between the readings of a Balling and those of a Brix instrument; both indicate the percentage of sugar present in a solution; for example, 20° correspond to 20 per cent of sugar, 20 pounds of sugar and 80 pounds of water. The Baumé hydrometer gives no information directly; the readings must be converted into terms of Brix, which requires the use of tables. This instrument should be discarded. The specific gravity hydrometer gives the weight of the sirup as compared with water, but has little practical use for the canner. All hydrometers are fragile and accurate only for a narrow range of temperature. Tables which give the conversion from one reading to another and also for making the necessary corrections for temperature have been appended (pp. 28–31).

To make a sirup of the various degrees, using 1 gallon of water as a basis, add the following quantities of sugar:

Amount of sugar necessary for sirup of various degrees.

Density, degrees Balling.	Quantity of sugar.			Density, degrees Balling.	Quantity of sugar.		
	Ounces.	Pounds and ounces.	Pounds.		Ounces.	Pounds and ounces.	Pounds.
5	7.0	.. 7	0.44	35	71.75	4 7¾	4.48
10	14.8	.. 14¾	.92	40	88.8	5 8¾	5.55
15	23.5	1 7½	1.47	45	109	6 13	6.81
20	30.8	1 14¾	1.92	50	133.3	8 5½	8.33
25	44.5	2 12½	2.8	55	163.9	10 4	10.24
30	57.12	3 9	3.57	60	200	12 8	12.5

Weight of sirup per gallon and in No. 2½ can.

Density, degrees Balling.	Weight of sirup.			Density, degrees Balling.	Weight of sirup.		
	Pounds per gallon.	Ounces per can.	Grams per can.		Pounds per gallon.	Ounces per can.	Grams per can.
0	8.34	31.3	887	35	9.62	36.1	1,024
5	8.5	31.9	904	40	9.8	36.9	1,046
10	8.67	32.5	922	45	10.05	37.7	1,069
15	8.84	33.2	941	50	10.27	38.6	1,093
20	9.03	33.9	960	55	10.51	39.3	1,118
25	9.22	34.6	981	60	10.75	40.3	1,144
30	9.41	35.4	1,002				

Average weights of No. 2½ cans of fruits, using different degrees of sirup, and quantity of sugar per can and per case. (Weight of fruit, 560 grams.)

Density of sirup (degrees).	Weight of contents.	Weight of sirup.				Weight of sugar per case.		
		Per can.		Per case.				
	Grams.	*Grams.*	*Ounces.*	*Grams.*	*Ounces.*	*Grams.*	*Lbs.*	*ozs.*
Water	835	275	9.7					
10	850	290	10.23	6,960	245.5	696	1	8.5
20	864	304	10.73	7,296	257.5	1,459	3	3.5
30	876	316	11.15	7,584	267.6	2,275	5	3
40	888	328	11.57	7,872	277.7	3,149	6	15
50	900	340	12	8,160	288	4,080	9	0
60	915	355	12.53	8,520	300.7	5,112	11	4.4

These weights vary slightly for different fruits, and in commercial packing the fill is not quite as strong as in these experiments. The figures, however, will furnish a fairly close guide as to the quantity of sugar required in canning. They also point to a cause of some of the difficulties in correct labeling under the new net-weight law.

Change in volume (in parts per 10,000) of sirups at different temperatures.

Temperature.	Volume of sirup.					Temperature.	Volume of sirup.				
	10°	20°	30°	40°	50°		10°	20°	30°	40°	50°
° *C.*						° *C.*					
5	4.5	7	9	12	16	55	170	183	196	210	229
10	12	16	21	26	32	60	197	209	222	235	253
15	21	28	34	42	50	65	225	236	249	261	278
20	33	41	49	58	69	70	255	265	277	287	306
25	48	57	66	75	88	75	284	295	306	316	332
30	64	74	84	94	110	80	316	325	335	345	360
35	82	92	103	114	132	85	347	355	365	375	388
40	101	112	124	136	156	90	379	387	395	405	417
45	122	134	146	160	180	95	411	418	425	435	445
50	145	156	170	184	204	100	442	450	456	465	473

Relation of Brix, specific gravity, and Baumé.

Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.
0.1	1.0003	0.06	6.6	1.0261	3.7	13.1	1.0531	7.3	19.6	1.0815	10.85
0.2	1.0007	0.11	6.7	1.0265	3.7	13.2	1.0536	7.3	19.7	1.0819	10.9
0.3	1.0011	0.17	6.8	1.0269	3.8	13.3	1.0540	7.4	19.8	1.0824	11.0
0.4	1.0015	0.22	6.9	1.0273	3.8	13.4	1.0544	7.4	19.9	1.0828	11.0
0.5	1.0019	0.28	7.0	1.0277	3.9	13.5	1.0548	7.5	20.0	1.0832	11.1
0.6	1.0023	0.33	7.1	1.0281	3.9	13.6	1.0553	7.5	20.1	1.0837	11.1
0.7	1.0027	0.39	7.2	1.0286	4.0	13.7	1.0557	7.6	20.2	1.0841	11.2
0.8	1.0031	0.44	7.3	1.0290	4.1	13.8	1.0561	7.65	20.3	1.0846	11.2
0.9	1.0034	0.5	7.4	1.0294	4.1	13.9	1.0566	7.7	20.4	1.0850	11.3
1.0	1.0038	0.55	7.5	1.0298	4.2	14.0	1.0570	7.8	20.5	1.0855	11.3
1.1	1.0042	0.6	7.6	1.0302	4.2	14.1	1.0574	7.8	20.6	1.0859	11.4
1.2	1.0046	0.7	7.7	1.0306	4.3	14.2	1.0578	7.9	20.7	1.0864	11.45
1.3	1.0050	0.7	7.8	1.0310	4.3	14.3	1.0583	7.9	20.8	1.0868	11.5
1.4	1.0054	0.8	7.9	1.0314	4.4	14.4	1.0587	8.0	20.9	1.0873	11.6
1.5	1.0058	0.8	8.0	1.0318	4.4	14.5	1.0591	8.0	21.0	1.0877	11.6
1.6	1.0062	0.9	8.1	1.0322	4.5	14.6	1.0596	8.1	21.1	1.0882	11.7
1.7	1.0066	0.9	8.2	1.0327	4.55	14.7	1.0600	8.15	21.2	1.0886	11.7
1.8	1.0070	1.0	8.3	1.0331	4.6	14.8	1.0604	8.2	21.3	1.0891	11.8
1.9	1.0074	1.05	8.4	1.0335	4.7	14.9	1.0609	8.3	21.4	1.0895	11.8
2.0	1.0077	1.1	8.5	1.0339	4.7	15.0	1.0613	8.3	21.5	1.0900	11.9
2.1	1.0081	1.2	8.6	1.0343	4.8	15.1	1.0617	8.4	21.6	1.0904	11.95
2.2	1.0085	1.2	8.7	1.0347	4.8	15.2	1.0621	8.4	21.7	1.0909	12.0
2.3	1.0089	1.3	8.8	1.0351	4.9	14.3	1.0626	8.5	21.8	1.0914	12.05
2.4	1.0093	1.3	8.9	1.0355	4.9	15.4	1.0630	8.5	21.9	1.0918	12.1
2.5	1.0097	1.4	9.0	1.0359	5.0	15.5	1.0634	8.6	22.0	1.0923	12.2
2.6	1.0101	1.4	9.1	1.0364	5.05	15.6	1.0639	8.65	22.1	1.0927	12.2
2.7	1.0105	1.5	9.2	1.0368	5.1	15.7	1.0643	8.7	22.2	1.0932	12.3
2.8	1.0109	1.55	9.3	1.0372	5.2	15.8	1.0647	8.8	22.3	1.0936	12.3
2.9	1.0113	1.6	9.4	1.0376	5.2	15.9	1.0652	8.8	22.4	1.0941	12.4
3.0	1.0117	1.7	9.5	1.0380	5.3	16.0	1.0656	8.9	22.5	1.0945	12.4
3.1	1.0121	1.7	9.6	1.0384	5.3	16.1	1.0660	8.9	22.6	1.0950	12.5
3.2	1.0125	1.8	9.7	1.0388	5.4	16.2	1.0665	9.0	22.7	1.0954	12.55
3.3	1.0129	1.8	9.8	1.0393	5.4	16.3	1.0669	9.0	22.8	1.0959	12.6
3.4	1.0133	1.9	9.9	1.0397	5.5	16.4	1.0674	9.1	22.9	1.0964	12.7
3.5	1.0137	1.9	10.0	1.0401	5.55	16.5	1.0678	9.1	23.0	1.0968	12.7
3.6	1.0141	2.0	10.1	1.0405	5.6	16.6	1.0682	9.2	23.1	1.0973	12.8
3.7	1.0145	2.0	10.2	1.0409	5.7	16.7	1.0687	9.25	23.2	1.0977	12.8
3.8	1.0149	2.1	10.3	1.0413	5.7	16.8	1.0691	9.3	23.3	1.0982	12.9
3.9	1.0153	2.2	10.4	1.0418	5.8	16.9	1.0695	9.4	23.4	1.0986	12.9
4.0	1.0157	2.2	10.5	1.0422	5.8	17.0	1.0700	9.4	23.5	1.0991	13.0
4.1	1.0161	2.3	10.6	1.0426	5.9	17.1	1.0704	9.5	23.6	1.0996	13.0
4.2	1.0165	2.3	10.7	1.0430	5.9	17.2	1.0709	9.5	23.7	1.1000	13.1
4.3	1.0169	2.4	10.8	1.0434	6.0	17.3	1.0713	9.6	23.8	1.1005	13.15
4.4	1.0173	2.4	10.9	1.0439	6.05	17.4	1.0717	9.6	23.9	1.1009	13.2
4.5	1.0177	2.5	11.0	1.0443	6.1	17.5	1.0722	9.7	24.0	1.1014	13.3
4.6	1.0181	2.6	11.1	1.0447	6.2	17.6	1.0726	9.75	24.1	1.1019	13.3
4.7	1.0185	2.6	11.2	1.0451	6.2	17.7	1.0730	9.8	24.2	1.1023	13.4
4.8	1.0189	2.7	11.3	1.0455	6.3	17.8	1.0735	9.9	24.3	1.1028	13.4
4.9	1.0193	2.7	11.4	1.0459	6.3	17.9	1.0739	9.9	24.4	1.1032	13.5
5.0	1.0197	2.8	11.5	1.0464	6.4	18.0	1.0744	10.0	24.5	1.1037	13.5
5.1	1.0201	2.8	11.6	1.0468	6.4	18.1	1.0748	10.0	24.6	1.1042	13.6
5.2	1.0205	2.9	11.7	1.0472	6.5	18.2	1.0753	10.1	24.7	1.1046	13.6
5.3	1.0209	2.9	11.8	1.0476	6.55	18.3	1.0757	10.1	24.8	1.1051	13.7
5.4	1.0213	3.0	11.9	1.0481	6.6	18.4	1.0761	10.2	24.9	1.1056	13.75
5.5	1.0217	3.0	12.0	1.0485	6.7	18.5	1.0766	10.2	25.0	1.1060	13.8
5.6	1.0221	3.1	12.1	1.0489	6.7	18.6	1.0770	10.3	25.1	1.1065	13.9
5.7	1.0225	3.2	12.2	1.0493	6.8	18.7	1.0775	10.35	25.2	1.1070	13.9
5.8	1.0229	3.2	12.3	1.0497	6.8	18.8	1.0779	10.4	25.3	1.1074	14.0
5.9	1.0233	3.3	12.4	1.0502	6.9	18.9	1.0783	10.5	25.4	1.1079	14.0
6.0	1.0237	3.3	12.5	1.0506	6.9	19.0	1.0788	10.5	25.5	1.1083	14.1
6.1	1.0241	3.4	12.6	1.0510	7.0	19.1	1.0792	10.6	25.6	1.1088	14.1
6.2	1.0245	3.4	12.7	1.0514	7.05	19.2	1.0797	10.6	25.7	1.1093	14.2
6.3	1.0249	3.5	12.8	1.0519	7.1	19.3	1.0801	10.7	25.8	1.1097	14.2
6.4	1.0253	3.6	12.9	1.0523	7.2	19.4	1.0806	10.7	25.9	1.1102	14.3
6.5	1.0257	3.6	13.0	1.0527	7.2	19.5	1.0810	10.8	26.0	1.1107	14.35

Relation of Brix, specific gravity, and Baumé—Continued.

Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.
26.1	1.1111	14.4	32.6	1.1422	17.9	39.1	1.1748	21.4	45.6	1.2088	24.9
26.2	1.1116	14.5	32.7	1.1427	18.0	39.2	1.1753	21.5	45.7	1.2093	24.9
26.3	1.1121	14.5	32.8	1.1432	18.0	39.3	1.1758	21.5	45.8	1.2099	25.0
26.4	1.1125	14.6	32.9	1.1437	18.1	39.4	1.1763	21.6	45.9	1.2104	25.0
26.5	1.1130	14.6	33.0	1.1442	18.15	39.5	1.1768	21.6	46.0	1.2110	25.1
26.6	1.1135	14.7	33.1	1.1447	18.2	39.6	1.1773	21.7	46.1	1.2115	25.1
26.7	1.1140	14.7	33.2	1.1452	18.25	39.7	1.1778	21.7	46.2	1.2120	25.2
26.8	1.1144	14.8	33.3	1.1457	18.3	39.8	1.1784	21.8	46.3	1.2126	25.2
26.9	1.1149	14.8	33.4	1.1462	18.4	39.9	1.1789	21.85	46.4	1.2131	25.3
27.0	1.1154	14.9	33.5	1.1466	18.4	40.0	1.1794	21.9	46.5	1.2136	25.35
27.1	1.1158	14.9	33.6	1.1471	18.5	40.1	1.1799	22.0	46.6	1.2142	25.4
27.2	1.1163	15.0	33.7	1.1476	18.5	40.2	1.1804	22.0	46.7	1.2147	25.45
27.3	1.1168	15.1	33.8	1.1481	18.6	40.3	1.1809	22.1	46.8	1.2153	25.5
27.4	1.1172	15.1	33.9	1.1486	18.6	40.4	1.1815	22.1	46.9	1.2158	25.6
27.5	1.1177	15.2	34.0	1.1491	18.7	40.5	1.1820	22.2	47.0	1.2163	25.6
27.6	1.1182	15.2	34.1	1.1496	18.7	40.6	1.1825	22.2	47.1	1.2169	25.7
27.7	1.1187	15.3	34.2	1.1501	18.8	40.7	1.1830	22.3	47.2	1.2174	25.7
27.8	1.1191	15.3	34.3	1.1506	18.85	40.8	1.1835	22.3	47.3	1.2180	25.8
27.9	1.1196	15.4	34.4	1.1511	18.9	40.9	1.1840	22.4	47.4	1.2185	25.8
28.0	1.1201	15.4	34.5	1.1516	18.95	41.0	1.1846	22.4	47.5	1.2191	25.9
28.1	1.1206	15.5	34.6	1.1521	19.0	41.1	1.1851	22.5	47.6	1.2196	25.9
28.2	1.1210	15.55	34.7	1.1526	19.1	41.2	1.1856	22.5	47.7	1.2201	26.0
28.3	1.1215	15.6	34.8	1.1531	19.1	41.3	1.1861	22.6	47.8	1.2207	26.0
28.4	1.1220	15.7	34.9	1.1536	19.2	41.4	1.1866	22.65	47.9	1.2212	26.1
28.5	1.1225	15.7	35.0	1.1541	19.2	41.5	1.1872	22.7	48.0	1.2218	26.1
28.6	1.1229	15.8	35.1	1.1546	19.3	41.6	1.1877	22.75	48.1	1.2223	26.2
28.7	1.1234	15.8	35.2	1.1551	19.3	41.7	1.1882	50.8	48.2	1.2229	26.2
28.8	1.1239	15.9	35.3	1.1556	19.4	41.8	1.1887	22.9	48.3	1.2234	26.3
28.9	1.1244	15.9	35.4	1.1561	19.4	41.9	1.1892	22.9	48.4	1.2240	26.35
29.0	1.1248	16.0	35.5	1.1566	19.5	42.0	1.1898	23.0	48.5	1.2245	26.4
29.1	1.1253	16.0	35.6	1.1571	19.55	42.1	1.1903	23.0	48.6	1.2250	26.45
29.2	1.1258	16.1	35.7	1.1576	19.6	42.2	1.1908	23.1	48.7	1.2256	26.5
29.3	1.1263	16.1	35.8	1.1581	19.65	42.3	1.1913	23.1	48.8	1.2261	26.6
29.4	1.1267	16.2	35.9	1.1586	19.7	42.4	1.1919	23.2	48.9	1.2267	26.6
29.5	1.1272	16.25	36.0	1.1591	19.8	42.5	1.1924	23.2	49.0	1.2272	26.7
29.6	1.1277	16.3	36.1	1.1596	19.8	42.6	1.1929	23.3	49.1	1.2278	26.7
29.7	1.1282	16.4	36.2	1.1601	19.9	42.7	1.1934	23.3	49.2	1.2283	26.8
29.8	1.1287	16.4	36.3	1.1606	19.9	42.8	1.1940	23.4	49.3	1.2289	26.8
29.9	1.1291	16.5	36.4	1.1611	20.0	42.9	1.1945	23.45	49.4	1.2294	26.9
30.0	1.1296	16.5	36.5	1.1616	20.0	43.0	1.1950	23.5	49.5	1.2300	26.9
30.1	1.1301	16.6	36.6	1.1621	20.1	43.1	1.1955	23.55	49.6	1.2305	27.0
30.2	1.1306	16.6	36.7	1.1626	20.1	43.2	1.1961	23.6	49.7	1.2311	27.0
30.3	1.1311	16.7	36.8	1.1631	20.2	43.3	1.1966	23.7	49.8	1.2316	27.1
30.4	1.1315	16.7	36.9	1.1636	20.2	43.4	1.1971	23.7	49.9	1.2322	27.1
30.5	1.1320	16.8	37.0	1.1641	20.3	43.5	1.1976	23.8	50.0	1.2327	27.2
30.6	1.1325	16.85	13.1	1.1646	20.35	43.6	1.1982	23.8	50.1	1.2333	27.2
30.7	1.1330	16.9	37.2	1.1651	20.4	43.7	1.1987	23.9	50.2	1.2338	27.3
30.8	1.1335	17.0	37.3	1.1656	20.5	43.8	1.1992	23.9	50.3	1.2344	27.3
30.9	1.1340	17.0	37.4	1.1661	20.5	43.9	1.1998	24.0	50.4	1.2349	27.4
31.0	1.1344	17.1	37.5	1.1666	20.6	44.0	1.2003	24.0	50.5	1.2355	27.45
31.1	1.1349	17.1	37.6	1.1671	20.6	44.1	1.2008	24.1	50.6	1.2361	27.5
31.2	1.1354	17.2	37.7	1.1676	20.7	44.2	1.2013	24.1	50.7	1.2366	27.55
31.3	1.1359	17.2	37.8	1.1681	20.7	44.3	1.2019	24.2	50.8	1.2372	27.6
31.4	1.1364	17.3	37.9	1.1686	20.8	44.4	1.2024	24.2	50.9	1.2377	27.7
31.5	1.1369	17.3	38.0	1.1692	20.8	44.5	1.2029	24.3	51.0	1.2383	27.7
31.6	1.1374	17.4	38.1	1.1697	20.9	44.6	1.2035	24.35	51.1	1.2388	27.8
31.7	1.1378	17.4	38.2	1.1702	20.9	44.7	1.2040	24.4	51.2	1.2394	27.8
31.8	1.1383	17.5	38.3	1.1707	21.0	44.8	1.2045	24.45	51.3	1.2399	27.9
31.9	1.1388	17.55	38.4	1.1712	21.05	44.9	1.2051	24.5	51.4	1.2405	27.9
32.0	1.1393	17.6	38.5	1.1717	21.1	45.0	1.2056	24.6	51.5	1.2411	28.0
32.1	1.1398	17.7	38.6	1.1722	21.15	45.1	1.2061	24.6	51.6	1.2416	28.0
32.2	1.1403	17.7	38.7	1.1727	21.2	45.2	1.2067	24.7	51.7	1.2422	28.1
32.3	1.1408	17.8	38.8	1.1732	21.3	45.3	1.2072	24.7	51.8	1.2427	28.1
32.4	1.1412	17.8	38.9	1.1737	21.3	45.4	1.2077	24.8	51.9	1.2433	28.2
32.5	1.1417	17.9	39.0	1.1743	21.4	45.5	1.2083	24.8	52.0	1.2439	28.2

Relation of Brix, specific gravity, and Baumé—Continued.

Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.
52.1	1.2444	28.3	58.6	1.2816	31.6	65.1	1.3205	34.95	71.6	1.3610	38.2
52.2	1.2450	28.3	58.7	1.2822	31.7	65.2	1.3211	35.0	71.7	1.3616	38.2
52.3	1.2455	28.4	58.8	1.2828	31.7	65.3	1.3217	35.05	71.8	1.3623	38.2
52.4	1.2461	28.4	58.9	1.2834	31.8	65.4	1.3223	35.1	71.9	1.3629	38.3
52.5	1.2467	28.5	59.0	1.2840	31.85	65.5	1.3229	35.15	72.0	1.3635	38.3
52.6	1.2472	28.5	59.1	1.2845	31.9	65.6	1.3235	35.2	72.1	1.3642	38.4
52.7	1.2478	28.6	59.2	1.2851	31.95	65.7	1.3241	35.25	72.2	1.3648	38.4
52.8	1.2483	28.65	59.3	1.2857	32.0	65.8	1.3247	35.3	72.3	1.3655	38.5
52.9	1.2489	28.7	59.4	1.2863	32.05	65.9	1.3253	35.35	72.4	1.3661	38.5
53.0	1.2495	28.75	59.5	1.2869	32.1	66.0	1.3260	35.4	72.5	1.3667	38.6
53.1	1.2500	28.8	59.6	1.2875	32.15	66.1	1.3266	35.4	72.6	1.3674	38.6
53.2	1.2506	28.85	59.7	1.2881	32.2	66.2	1.3272	35.5	72.7	1.3680	38.7
53.3	1.2512	28.9	59.8	1.2887	32.3	66.3	1.3278	35.5	72.8	1.3687	38.7
53.4	1.2517	28.9	59.9	1.2893	32.3	66.4	1.3285	35.6	72.9	1.3693	38.8
53.5	1.2523	29.0	60.0	1.2898	32.4	66.5	1.3291	35.6	73.0	1.3699	38.8
53.6	1.2529	29.1	60.1	1.2904	32.4	66.6	1.3297	35.7	73.1	1.3705	38.9
53.7	1.2534	29.1	60.2	1.2910	32.5	66.7	1.3303	35.7	73.2	1.3712	38.9
53.8	1.2540	29.2	60.3	1.2916	32.5	66.8	1.3309	35.8	73.3	1.3719	39.0
53.9	1.2546	29.2	60.4	1.2922	32.6	66.9	1.3315	35.8	73.4	1.3725	39.0
54.0	1.2551	29.3	60.5	1.2928	32.6	67.0	1.3322	35.9	73.5	1.3732	39.1
54.1	1.2557	29.3	60.6	1.2934	32.7	67.1	1.3327	35.9	73.6	1.3738	39.1
54.2	1.2563	29.4	60.7	1.2940	32.7	67.2	1.3334	36.0	73.7	1.3745	39.2
54.3	1.2568	29.4	60.8	1.2946	32.8	67.3	1.3340	36.0	73.8	1.3751	39.2
54.4	1.2574	29.5	60.9	1.2952	32.8	67.4	1.3346	36.1	73.9	1.3757	39.3
54.5	1.2580	29.5	61.0	1.2958	32.9	67.5	1.3352	36.1	74.0	1.3764	39.3
54.6	1.2585	29.6	61.1	1.2964	32.9	67.6	1.3359	36.2	74.1	1.3770	39.4
54.7	1.2591	29.6	61.2	1.2970	33.0	67.6	1.3365	36.2	74.2	1.3777	39.4
54.8	1.2597	29.7	61.3	1.2975	33.0	67.8	1.3371	36.3	74.3	1.3783	39.5
54.9	1.2602	29.7	61.4	1.2981	33.1	67.9	1.3377	36.3	74.4	1.3790	39.5
55.0	1.2608	29.8	61.5	1.2987	33.1	68.0	1.3384	36.4	74.5	1.3796	39.6
55.1	1.2614	29.8	61.6	1.2993	33.2	68.1	1.3390	36.4	74.6	1.3803	39.6
55.2	1.2620	29.9	61.7	1.2999	33.2	68.2	1.3396	36.5	74.7	1.3809	39.7
55.3	1.2625	29.9	61.8	1.3005	33.3	68.3	1.3402	36.5	74.8	1.3816	39.7
55.4	1.2631	30.0	61.9	1.3011	33.3	68.4	1.3408	36.6	74.9	1.3822	39.8
55.5	1.2637	30.05	62.0	1.3017	33.4	68.5	1.3415	36.6	75.0	1.3828	39.8
55.6	1.2642	30.1	62.1	1.3023	33.4	68.6	1.3421	36.7	75.1	1.3835	39.9
55.7	1.2648	30.15	62.2	1.3029	33.5	68.7	1.3427	36.7	75.2	1.3842	39.9
55.8	1.2654	30.2	62.3	1.3035	33.5	68.8	1.3433	36.8	75.3	1.3848	40.0
55.9	1.2660	30.25	62.4	1.3041	33.6	68.9	1.3440	36.8	75.4	1.3855	40.0
56.0	1.2665	30.3	62.5	1.3047	33.6	69.0	1.3446	36.9	75.5	1.3861	40.1
56.1	1.2671	30.4	62.6	1.3053	33.7	69.1	1.3452	36.9	75.6	1.3868	40.1
56.2	1.2677	30.4	62.7	1.3059	33.7	69.2	1.3458	37.0	75.7	1.3874	40.2
56.3	1.2683	30.5	62.8	1.3065	33.8	69.3	1.3465	37.0	75.8	1.3880	40.2
56.4	1.2688	30.5	62.9	1.3071	33.8	69.4	1.3471	37.1	75.9	1.3887	40.3
56.5	1.2694	30.6	63.0	1.3077	33.9	69.5	1.3477	37.1	76.0	1.3894	40.3
56.6	1.2700	30.6	63.1	1.3083	33.9	69.6	1.3484	37.2	76.1	1.3900	40.4
56.7	1.2706	30.7	63.2	1.3089	34.0	69.7	1.3490	37.2	76.2	1.3907	40.4
56.8	1.2712	30.7	63.3	1.3095	34.0	69.8	1.3496	37.3	76.3	1.3913	40.5
56.9	1.2717	30.8	63.4	1.3101	34.1	69.9	1.3502	37.3	76.4	1.3920	40.5
57.0	1.2723	30.8	63.5	1.3107	34.1	70.0	1.3509	37.4	76.5	1.3926	40.6
57.1	1.2729	30.9	63.6	1.3113	34.2	70.1	1.3515	37.4	76.6	1.3933	40.6
57.2	1.2735	30.9	63.7	1.3119	34.2	70.2	1.3521	37.5	76.7	1.3940	40.7
57.3	1.2740	31.0	63.8	1.3126	34.3	70.3	1.3528	37.5	76.8	1.3946	40.7
57.4	1.2746	31.0	63.9	1.3132	34.3	70.4	1.3534	37.6	76.9	1.3953	40.8
57.5	1.2752	31.1	64.0	1.3138	34.4	70.5	1.3540	37.6	77.0	1.3959	40.8
57.6	1.2758	31.1	64.1	1.3144	34.4	70.6	1.3546	37.7	77.1	1.3966	40.8
57.7	1.2764	31.2	64.2	1.3150	34.5	70.7	1.3553	37.7	77.2	1.3972	40.9
57.8	1.2769	31.2	64.3	1.3156	34.5	70.8	1.3559	37.8	77.3	1.3979	41.0
57.9	1.2775	31.3	64.4	1.3162	34.6	70.9	1.3565	37.8	77.4	1.3986	41.0
58.0	1.2781	31.3	64.5	1.3168	34.6	71.0	1.3572	37.9	77.5	1.3992	41.0
58.1	1.2787	31.4	64.6	1.3174	34.7	71.1	1.3578	37.9	77.6	1.3999	41.1
58.2	1.2793	31.4	64.7	1.3180	34.7	71.2	1.3585	38.0	77.7	1.4005	41.1
58.3	1.2799	31.5	64.8	1.3186	34.8	71.3	1.3591	38.0	77.8	1.4012	41.2
58.4	1.2804	31.5	64.9	1.3192	34.8	71.4	1.3597	38.1	77.9	1.4019	41.2
58.5	1.2810	31.6	65.0	1.3198	34.9	71.5	1.3604	38.1	78.0	1.4025	41.3

Relation of Brix, specific gravity, and Baumé—Continued.

Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.	Per cent of sugar.	Specific gravity.	Degrees Baumé.
78.1	1.4032	41.3	80.1	1.4165	42.3	82.1	1.4300	43.3	84.1	1.4437	44.2
78.2	1.4039	41.4	80.2	1.4172	42.3	82.2	1.4307	43.3	84.2	1.4443	44.3
78.3	1.4045	41.4	80.3	1.4179	42.4	82.3	1.4314	43.4	84.3	1.4450	44.3
78.4	1.4052	41.5	80.4	1.4185	42.4	82.4	1.4320	43.4	84.4	1.4457	44.3
78.5	1.4058	41.5	80.5	1,4192	42.5	82.5	1.4327	43.5	84.5	1.4464	44.4
78.6	1.4065	41.6	80.6	1.4199	42.5	82.6	1.4334	43.5	84.6	1.4471	44.4
78.7	1.4072	41.6	80.7	1.4205	42.6	82.7	1.4341	43.5	84.7	1.4478	44.5
78.8	1.4078	41.7	80.8	1.4212	42.6	82.8	1.4348	43.6	84.8	1.4485	44.5
78.9	1.4085	41.7	80.9	1.4219	42.7	82.9	1.4354	43.6	84.9	1.4492	44.6
79.0	1.4092	41.8	81.0	1.4226	42.7	83.0	1.4361	43.7	85.0	1.4498	44.6
79.1	1.4098	41.8	81.1	1.4232	42.8	83.1	1.4368	43.7	85.1	1.4505	44.7
79.2	1.4105	41.9	81.2	1.4239	42.8	83.2	1.4375	43.8	85.2	1.4512	44.7
79.3	1.4112	41.9	81.3	1.4246	42.9	83.3	1.4382	43.8	85.3	1.4519	44.8
79.4	1.4119	42.0	81.4	1.4253	42.9	83.4	1.4388	43.9	85.4	1.4526	44.8
79.5	1.4125	42.0	81.5	1.4259	43.0	83.5	1.4395	43.9	85.5	1.4533	44.9
79.6	1.4132	42.1	81.6	1.4266	43.0	83.6	1.4402	44.0	85.6	1.4540	44.9
79.7	1.4138	42.1	81.7	1.4273	43.1	83.7	1.4409	44.0	85.7	1.4547	45.0
79.8	1.4145	42.2	81.8	1.4280	43.1	83.8	1.4416	44.1	85.8	1.4554	45.0
79.9	1.4152	42.2	81.9	1.4287	43.2	83.9	1.4423	44.1	85.9	1.4561	45.1
80.0	1.4158	42.2	82.0	1.4293	43.2	84.0	1.4430	44.2	86.0	1.4568	45.1

Correction for the readings of Balling's saccharimeter, on account of temperature.

TO BE SUBTRACTED FROM THE DEGREE READ.

Temp.	Per cent of sugar in solution.												
C.	0	5	10	15	20	25	30	35	40	50	60	70	75
13	0.14	0.18	0.19	0.21	0.22	0.24	0.26	0.27	0.28	0.29	0.33	0.35	0.39
14	.12	.15	.16	.17	.18	.19	.21	.22	.22	.23	.26	.28	.32
15	.09	.11	.12	.14	.14	.15	.16	.17	.16	.17	.19	.21	.25
16	.06	.07	.08	.09	.10	.10	.11	.12	.12	.12	.14	.16	.18
17	.02	.02	.03	.03	.03	.04	.04	.04	.04	.04	.05	.05	.06
TO BE ADDED TO THE DEGREE READ.													
18	.02	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.03	.02
19	.06	.08	.08	.09	.09	.10	.10	.10	.10	.10	.10	.08	.06
20	.11	.14	.15	.17	.17	.18	.18	.18	.19	.19	.18	.15	.11
21	.16	.20	.22	.24	.24	.25	.25	.25	.26	.26	.25	.22	.18
22	.21	.26	.29	.31	.31	.32	.32	.32	.33	.34	.32	.29	.25
23	.27	.32	.35	.37	.38	.39	.39	.39	.40	.42	.39	.36	.33
24	.32	.38	.41	.43	.44	.46	.46	.47	.47	.50	.46	.43	.40
25	.37	.44	.47	.49	.51	.53	.54	.55	.55	.58	.54	.51	.48
26	.43	.50	.54	.56	.58	.60	.61	.62	.62	.66	.62	.58	.55
27	.49	.57	.61	.63	.65	.68	.68	.69	.70	.74	.70	.65	.62
28	.56	.64	.68	.70	.72	.76	.76	.78	.78	.82	.78	.72	.70
29	.63	.71	.75	.78	.79	.84	.84	.86	.86	.90	.86	.80	.78
30	.70	.78	.82	.87	.87	.92	.92	.94	.94	.98	.94	.88	.86

While the Brix or Balling spindle gives the percentage of sugar in a sirup, this is not true for the fruit sirup, where the reading indicates soluble solids and is always higher than the actual sugar content. As will be seen in following the tables on fruits, the Balling reading serves, however, as an excellent index for the sirup used, and in the establishment of grades should be used on the cut-out, rather than the quantity of sugar claimed to have been added. In the trade fruits graded as extra and special extra are put up in heavy sirup; extra standard and standard, in medium sirup; and

sometimes standard and seconds, in light sirup. Those packed without sirup are known as water or pie fruit.

There is no chemical difference between a high-grade granulated sugar made from sugar cane and one made from sugar beets, though canners have been taught that there is a difference in favor of cane sugar and pay a premium of from 10 to 20 cents per hundred pounds for it. Some of the best packers make no discrimination now except on the basis of price. Both kinds of sugar were used in the experimental work and no difference was observed except in one case of beet sugar, in which the difference was apparently due to the sulphids present. A rather ashen gray color was given to white cherries and the delicate color in some of the berries was destroyed. Chemical tests showed the presence of sulphid, and leaving a silver or aluminum spoon in the sugar overnight was sufficient to cause blackening. How far such troubles extend in canning is not known.

Apples (Pyrus malus).

Apples used for canning should be of varieties that cook well. They should be slightly acid, smooth and sound, and without bruised spots. Poor apples can not be used in canning and make a first-class product. The peeling is done by hand or power peelers and the core removed by the same operation or with a coring machine. Apples which are intended for dumplings are left whole and graded into sizes to give a certain number to the can, but those intended for pies or other cooking purposes are sliced in quarters or smaller pieces. The peeled apple is placed in cans as quickly as possible and hot water added to make the fill. If the apples can not be packed in the can at once, they are held in tubs of cold water to prevent their oxidizing or turning brown. The process on apples is about 8 minutes at 212° F. for No. 3 cans and about 10 minutes for No. 10 cans.

The waste in the proportion of good apples will be from 20 to 40 per cent, depending in a measure upon whether they are cut into small slices for pie stock or allowed to remain whole for dumplings. The waste is used for jelly stock, and dried for chops and vinegar. The method of utilization depends upon the quality.

Apricots (Prunus armeniaca).

The apricot is produced for canning and drying in its highest state of development in California. It is one of the good fruits with a distinctive and agreeable flavor, although this is not developed until the fruit is ripe and ready to turn soft. If packed at this stage and a proper sirup used, it is delicious. If packed while immature, it possesses an astringent and peculiar bitter taste that is unpleasant. If it is allowed to become overripe and soft, it melts down under the process and does not have an attractive appearance. The period for proper canning is therefore short, which accounts for much of the inferior product found upon the market. The fruit is grown, hand picked, and boxed for the factory as peaches are. At some factories they are graded for size by running the fruit over screens having openings 40, 48, 56, 64, and 68 thirty-seconds of an inch in size. The apricot is not usually peeled; it is pitted and thoroughly washed, and any black spots (called soot or smut) on the surface are carefully trimmed off. The great bulk of the crop is simply split along the pit mark and left in halves, a few are peeled, and a few are sliced for a special or fancy trade.

The cans are filled by hand, the fillers using some care in separating fruit for quality after it has come to them graded for size. Fancy stock must be evenly ripened, of good color, and free from spots or defects. The underripe, soft, and badly smutted pieces are separated for seconds and water-stock. The fruit receives the appropriate sirup, is exhausted until hot, and processed for from 6 to 12 minutes.

An experiment was made to compare underripe and ripe fruit, the stock being selected from the same source and picking. The fruit which was in prime condition for canning was separated into one lot, and that which was evidently green, but which

would have been used in the factory, was separated into another lot. The treatment of the two lots was identical, a 10° sirup being used in canning. A second experiment was made to compare apricots ripened on the tree with those ripened in storage. Fruit was again selected from the same source and picking and the prime-ripe canned at once, the green being held in boxes and ripened in the laboratory. The preparation and treatment were the same as in the first experiment, but a 30° sirup was used. Both sets show very clearly a difference on the cut-out in appearance and flavor, and this is confirmed by the chemical examination. The green fruit shows in the paler and greener color greater solidity, sharper-cut edges, and pronounced acid taste. The characteristic green taste persisted in the storage ripened and was only slightly less marked than in the fresh green fruit. A difference is shown chemically in acidity and in the form in which the sugar is present. This work was duplicated in 1913 under slightly different conditions but with the same general result, showing clearly the superiority of tree-ripened over green or storage-ripened fruit.

The use of underripe stock is largely the result of the form of contract which the canner makes with the grower. It calls for the entire crop from an orchard, and at picking time the trees are stripped when the great bulk is ripe, with the result that some of those fruits which should have been left are taken. After the fruit once reaches the factory there is the same impetus to pass on. Of all the immature fruits examined the apricot is probably the most objectionable.

The apricot is decidedly acid and requires a rather heavy sirup to make it acceptable to most persons. Packing in light sirup means that the consumer must add sugar at the time of consumption, when it will require more to secure the same result than if it had been added in the can. An apricot that will not justify the use of a 20° sirup is hardly worth the canning. Apricots are also packed kettle cooked, or in the form of a heavy sauce or butter. The fruit selected for this purpose is usually soft ripe. It is rubbed through a screen to remove the skins and secure smoothness, and evaporated in a jacketed kettle until the desired consistency is obtained. Sugar may or may not be added. For a certain trade halves or slices of firm fruit are added just before the close of the cooking. This makes an excellent product, but is better known abroad than in this country.

The effect of varying densities of sirup upon the apricot is shown in the following table:

Effect of varying degrees of sirup on apricots and the "cut-out" sirup.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
1. Moor park; weight of fruit, 480 grams;[1] examined July 17, 1912, and Apr. 10, 1913:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams. per 100 cc.*	*Grams per 100 cc.*
Water	94[5]	805	455	350	9.41	2.75	2.66	0.52
10	995	855	472	383	14.4	4.75	5.57	.80
	995	855	480	375	14.5	5.75	4.75	.81
30	1,020	880	450	430	25.8	6.75	14.85	.72
	1,015	875	460	415	25.3	10.50	9.02	.81
40	1,065	925	452	473	33.5	6.37	23.17	.67
	1,055	915	480	435	30.4	10.50	13.78	.78
50	1,085	945	458	487	37.0	6.25	26.07	.79
	1,085	945	455	490	35.3	13.25	16.39	.69
60	1,105	965	410	555	41.2	7.50	29.45	.70
	1,090	950	460	490	39.3	20.25	15.44	.73

[1] Through an error in setting the scale, the weight of fruit obtained was 480 grams, which is below commercial practice, and therefore the proportions of fruit and sirup are not quite correct, though the physical and chemical changes are properly shown.

Effect of varying degrees of sirup on apricots and the "cut-out" sirup—Continued.

Density of sirup (degrees).	Gross Weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
2. Royal apricot; weight of fruit, 550 grams; examined July 2, 29, 1913, and Jan. 20, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	995	855	530	325	9.8	4.75	0.00	1.18
	990	850	590	260	10.2	4.75	.24	1.28
	990	850	520	330	8.7	4.74	.97	1.01
10	975	835	510	325	13.6	5.00	4.75	1.26
	970	830	565	265	14.4	5.00	5.70	1.27
	970	830	610	220	14.3	6.54	2.67	1.36
20	1,010	870	540	330	17.8	5.00	9.26	1.19
	1,010	870	555	335	17.0	5.00	8.20	1.17
	1,005	865	550	315	17.3	8.55	3.78	1.27
30	1,045	905	525	380	22.5	5.25	13.30	1.18
	1,040	900	535	365	22.4	6.00	12.36	1.18
	1,025	885	590	295	22.3	10.70	6.48	1.32
40	1,055	915	505	410	26.8	8.50	14.73	1.13
	1,055	915	585	330	26.2	8.50	12.83	1.13
	1,045	905	580	325	27.4	14.82	7.45	1.19
50	1,065	925	510	415	30.0	8.50	19.47	1.11
	1,065	925	540	385	30.6	9.25	16.39	1.13
	1,060	920	540	380	32.2	17.91	10.26	1.20
60	1,075	935	490	445	37.3	5.00	28.50	1.04
	1,070	930	510	420	35.8	7.50	23.75	1.18
	1,065	925	545	380	35.5	21.52	9.33	1.32
Ripe fruit, 10	980	840	465	375	14.20	4.00	7.84	.79
Green fruit, 10	980	840	460	380	13.40	4.75	4.99	.88
Prime ripe, 30, 560 grams	1,045	905	505	400	24.50	8.25	13.06	.60
Laboratory ripened, 30, 560 grams	1,040	900	550	350	21.80	5.50	10.92	.86

Average weight and composition of the sirup in canned apricots, and the variations above and below the average.

Grade of fruit and density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Extra 40° sirup:								
Average	1,043	903	485	418	24.1	2.86	18.06	0.65
Highest	1,095	955	510	445	26.8	3.75	20.66	.83
Lowest	1,020	880	450	390	21.4	2.25	16.39	.53
Extra standard, 30°:								
Average	1,023	883	465	418	20.7	3.47	13.65	.64
Highest	1,050	910	485	435	23.2	4.50	15.44	.73
Lowest	1,010	870	450	410	18.6	2.50	12.39	.52
Standard, 20°:								
Average	992	852	465	387	15.6	2.46	9.21	.70
Highest	1,045	905	570	460	17.4	3.50	10.21	1.02
Lowest	960	820	390	335	13.5	1.50	6.65	.53
Seconds, 10°:								
Average	999	859	503	356	14.1	2.44	9.90	.77
Highest	1,020	880	565	420	17.0	2.75	10.45	.88
Lowest	950	810	450	315	11.5	2.23	5.94	.58
Water-packed:								
Average	965	825	448	377	11.0	2.17	5.16	.61
Highest	1,000	860	480	400	15.3	2.75	9.03	.69
Lowest	945	805	410	350	8.2	1.25	2.66	.52

The apricot does not hold its form or clear-cut outline in the can as well as many other fruits. The pieces soften more or less, resulting in loss of shape and a tendency to pack together, especially if well ripened. The fill on the cut-out does not vary very much with the degree of sirup. If the can has been well filled, it should cut out about two-thirds full, though the variation between cans of the same degree of sirup may be as great as between the fill of different degrees. The waste in packing

unpeeled apricots is from 9 to 15 per cent and in the peeled about 35 per cent. The pits are dried and exported for apricot oil. The windfalls, waste from the peeling tables, and overripe stock are used for brandy.

Blackberries (Rubus villosus).

The blackberry is one of the very widely distributed berries, in some sections growing wild in such profusion that no attempt is made at cultivation. The vine is very hardy and under favorable conditions is a prolific bearer. The cultivated berry has been increased in size and is of good texture and flavor. The surplus crop is canned in many parts of the United States, but it has not been developed as a special product to the extent that its quality warrants. Owing to the large yield, it should be produced at less expense than most berries, and if given the proper sirup to develop its flavor it should be received favorably by the consumer.

All berries should be collected in shallow drawers or trays and delivered promptly to the factory after being picked. It is the picking in buckets and delivering to country stores, allowing the fruit to stand for probably a day or more, and then shipping to factories in boxes in such thick layers that the bottom berries are mashed that have brought blackberries into disrepute.

On their arrival at the factory they should be hand picked to remove bits of stems, leaves, and defective fruit, and then washed in single layers under sprays of water, so that every part may be cleansed. The berries should be filled into cans by weight, the very large ones 19 to 19.5 ounces, and small ones 20 to 21 ounces. To secure this fill it may be necessary to tap the cans lightly, but not enough to mash or mar the fruit.

In experimental packing the cans were filled with 450, 500, 550, and 600 grams (16, 18, 19.6, and 21.4 ounces), and 50° sirup was used. The berries were of good size and quality. The 450-gram fill was slack and on the cut-out gave fruit which was whole and separate, but which did not occupy one-half the space after draining. The fruit in the cans with 500 grams lacked about three-fourths of an inch of coming to the top when packing. The berries remained whole and separate and occupied more than one-half the space after draining. The set having 550 grams was nearly level full and some cans needed slight tapping in order to keep the berries below the sirup. On cutting out the berries were separate, whole, and occupied two-thirds of the space. The cans filled with 600 grams of fruit required sharp tapping to cause them to settle to the level of the sirup. They were evidently overfilled for practical factory work. On exhausting, some of the berries would be forced out. The finished product showed only a slight matting at the bottom and fully three-fourths of the space was occupied after draining. With the grade of fruit used in the experiment it was evident that from 19.5 to 20 ounces made a full can.

The physical condition of the product in the can is influenced by the length of time given in processing and by cooling or not cooling after the process is completed. The fruit subjected to a short cooking and cooling usually retains a better shape and appearance; prolonged cooking or allowing the heat to be retained for a long time results in breaking it, and making more or less of a pulp. With delicate berries, however, the cooling should not be too sudden for the best results. The effect goes further than mere appearance; cooling affects the composition of the sirup, especially the quantity of sugar which will be inverted. The longer the heat is maintained the more sugar will be inverted. The difference between cooling and not cooling upon the inversion is greater than the difference in the effect of cooking for 5 or 25 minutes.

The inside lacquered can was found to be much superior to the plain tin in holding color. The loss in canning blackberries will vary from about 10 to 18 per cent on good fruit.

Effect of varying the quantity of blackberries in a can.

Weight of fruit used (grams).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Sirup 50° Balling:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
450	1,035	895	367	528	32.7	13.75	15.43	0.57
500	1,025	890	410	475	30.5	13.63	13.79	.58
550	1,040	900	435	465	28.5	13.25	14.35	.57
600	1,022	882	477	405	25.9	11.50	12.10	.79
Commercially packed:								
Water grade	924	784	365	419	7.6	.....	.....	.....
Standard	971	831	383	448	15.0	.....	.....	.....
Extra standard	988	848	433	415	17.4	.....	.....	.....

Effect of varying degrees of sirup on blackberries.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
1. Mammoth; weight of fruit, 500 grams; pack of 1912; examined July 17, Aug. 4, 1912, and Jan. 12, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams. per 100 cc.*	*Grams per 100 cc.*
Water	970	830	445	385	7.3	5.75	0.24	0.45
	980	840	450	390	7.1	5.00	.00	.45
	970	830	435	295	7.3	5.16	.16	.39
	960	820	445	375	11.8	6.25	3.80	.45
10	970	830	450	380	12.0	6.25	2.61	.38
	965	825	430	395	12.0	7.57	2.63	.41
	1,015	875	450	425	17.7	7.50	8.31	.40
20	1,010	870	445	425	17.8	7.50	7.84	.42
	1,005	865	445	420	17.5	10.38	5.37	.42
	1,005	865	440	425	20.9	8.5	9.74	.39
30	1,015	875	440	435	22.7	8.5	10.93	.40
	1,010	870	450	420	21.2	10.63	8.70	.37
	1,050	910	450	460	24.4	9.50	9.50	.50
40	.....	.....	.....	.....	24.9	9.75	9.50	.47
	10.35	895	500	395	24.1	14.42	7.55	.51
	1,072	932	420	512	28.8	11.65	14.48	.54
50	1,077	937	450	487	31.0	14.25	12.58	.52
	1,055	915	440	475	28.4	19.91	6.05	.58
	1,085	945	395	550	35.0	26.0	5.70	.44
60	1,080	945	485	460	34.4	31.88	.68	.52
2. Weight of fruit used, 550 grams; pack of 1913; examined June 27, Aug. 1, 1913, and Jan. 22, 1914:								
Water	950	810	465	345	7.0	5.25	.00	.82
	965	825	480	345	7.2	5.25	.00	.87
	960	820	470	350	7.5	4.45	.02	.93
	985	845	470	375	15.2	7.50	4.75	.92
20	990	850	470	380	15.2	9.25	3.32	.77
	980	840	460	380	14.8	10.20	2.06	.88
	1,000	860	445	415	19.3	8.50	8.08	.79
30	990	850	450	400	19.4	10.25	6.65	.75
	1,015	875	465	310	19.4	13.10	3.40	.96
	1,010	870	435	435	22.6	10.00	9.97	.77
40	1,040	900	465	435	23.4	10.50	9.50	.72
	1,015	875	490	385	22.7	14.51	6.10	.74
	1,045	905	395	510	28.1	10.25	14.49	.59
50	1,055	915	430	425	27.8	11.00	15.35	.68
	1,045	905	490	415	27.9	17.48	7.54	.74
	1,055	915	375	540	33.5	14.25	15.44	.68
60	1,055	915	420	395	32.4	14.25	14.96	.76
	1,070	930	480	350	33.0	23.82	7.25	.80

The effect of sirup upon the fill of the can when 550 grams were used was as follows: Berries water-packed, can lacked 1 inch of being full on the cut-out; 20° sirup, lacked 1 inch; 30° sirup, lacked 1¼ inches; 40°, more than two-thirds full; 50°, about two-thirds full; and 60°, somewhat less than two-thirds full; 450 grams, one-half full; 500 grams, two-thirds full or slightly less; 550 grams, two-thirds full; and 600 grams, to within 1 inch of the top. The experimental pack for both years showed that the use of 40° and 50° sirups gave the better results, there being a slight preference for the latter. The berries preserved their identity, shape, texture, and color better than in the sirups of lower degree and were not so much shrunken or toughened as in 60°. The flavor in 40° was mildly tart and in 50° it was sweet, but both were distinctive of the fruit. The fruit packed in these sirups also stood shipping well.

Cherries (Prunus cerasus).

The cherry, while largely grown for table purposes, is mainly obtained for canning and preserving in California, Oregon, New York, and Michigan. Of the several varieties used the Royal Anne is the most popular. A cherry to be well adapted for canning should have a characteristic flavor, not strongly acid, should remain whole, and not discolor in the can. It is a waste of good time and material to pack the varieties with excessive pits, which split open, producing a flat, insipid flavor.

Cherries should be delivered with the stems attached, in small or shallow boxes, as for the retail trade. They should be stemmed and washed. If they are to be graded for size, they are passed over screens having perforations of 22, 24, 26, 28, and 32 thirty-seconds of an inch. The cherry may or may not be pitted. Some prefer the unpitted fruit because of the flavor. Since the development of good pitting machines and the lessening of hand labor, however, the percentage of pitted fruit is becoming much higher. The mechanical pitters are based upon the principle of holding the cherry in a cup and thrusting a cutting plunger through it, thus forcing out the pit. They all lacerate the fruit more or less, but not more than hand pitting. For the latter a special scoop or pitting spoon is used, being inserted in the stem end to draw out the pit. A small handle bearing three wire points about an inch in length arranged in the form of a triangle just large enough to hold a pit makes a good instrument. It is forced through the cherry, driving the pit out at the stem end. The holes made in puncturing are small and scarcely noticeable after processing. After pitting, the fruit should be kept in thin layers until placed in the can. The quantity should be weighed for each can, 1 ounce more being allowed for pitted than for unpitted fruit in a No. 2 can. The sirup used should not be heavy on Royal Anne or cherries of a similar type, as a heavy sirup of 50° or 60° causes a marked shrinkage. A sirup up to 30° causes very little shrinkage and gives about all the sweetness that the product will stand without injuring the flavor. The 40° sirup causes some shrinkage in pitted fruit, but not much in whole fruit which is firm at the time of canning. In the experimental work it was found that the rate of heating had a great deal to do with the shrinkage and tenderness of the fruit. When 50° or 60° sirup, boiling, was placed on the cherries and followed with a strong three-minute exhaust, according to general practice, the shrinkage was pronounced and the fruit toughened. When the sirup was added at about 120° F. and heat gradually applied until it reached 190° F. in 30 minutes, very little shrinkage took place and the fruit remained very tender. The best results were obtained when about 45 minutes were given to the operation. Much of the splitting can be avoided by the same practice. Some packers heat their cherries in the jacketed kettle before canning, the object being to soften the fruit with heavy sirup to get a better fill. This is done to a greater extent with rather acid fruit than with the sweet. It has some advantages, but necessarily increases the labor.

Experimental lots of fruit were canned, using 400, 450, 500, 540, 560, and 600 grams in water. The weight of the fruit on the cut-out for the corresponding lots was 405, 445, 510, 530, 550, and 580 grams, there being very little change. The fill from using only 400 and 450 grams was clearly short weight; the use of 500 grams gave a slightly slack fill; and with 600 grams the can was somewhat too full. To use 540 and 560 grams required tapping of some cans, in order to get the fruit in, but, on the whole, they were easily filled. On the cut-out they lacked only a little more than one-half inch of being full after draining.

Experiments were made in canning cherries with sirups varying from 10° to 60°. The cherries were divided into three lots: Small, or those passing through a No. 26 sieve; large, those remaining above a No. 30 sieve; and a medium size which were pitted. For comparative purposes, the average of the examinations of the commercially canned article has been added to the table. The four grades which were available were extra (30° sirup), extra standard (20° sirup), standard (10° sirup), and seconds (water).

The waste consists of stems and pits. The loss in canning cherries with pits varies from about 15 to 18 per cent, and, when pitted, from 25 to 35 per cent. The loss with small cherries is much greater than with large ones, as the pits do not vary as much as the pulp. The cherry stems and pits are dried and used for flavoring in cough sirups, etc.

Effect of canning cherries in sirups of different degrees. (Royal Anne; weight of fruit used, 500 grams in No. 2½ can.)

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Small cherries:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	990	850	505	345	10.60	8.00	0.00	0.42
10	990	850	500	350	14.6	8.25	2.14	.38
20	1,020	880	485	395	20.1	7.75	7.60	.39
30	1,030	890	470	420	24.4	10.50	10.45	.39
40	1,015	875	440	435	29.9	11.00	13.30	.43
50	1,095	955	405	550	36.0	10.75	21.61	.38
60	1,085	945	380	565	40.2	11.00	20.90	.38
Large cherries:								
Water	1,010	870	530	340	10.5	6.00	.71	.33
10	1,020	880	495	385	16.0	9.50	2.14	.34
20	1,020	880	495	385	21.3	10.50	5.70	.37
30	1,050	910	470	440	26.2	10.50	11.16	.33
40	1,060	920	440	480	31.6	10.50	16.62	.37
50	1,080	940	400	540	37.7	12.75	17.81	.35
60	1,090	950	380	570	40.5	11.00	23.75	.37
Pitted cherries:								
10	980	840	465	375	18.7	10.50	4.27	.32
20	975	835	460	375	20.5	10.50	5.46	.37
30	1,025	880	405	475	25.4	9.75	11.64	.39
40	1,045	905	440	465	31.9	12.25	14.01	.40
50	1,075	935	425	490	33.8	10.75	18.29	.43
60	1,060	920	435	485	39.2	.....	.....	.38
Average commercially canned cherries:								
Water	984	844	584	260	14.0	.....	.....	.....
Seconds	978	838	526	312	12.1	5.67	3.48	.37
Standards	999	859	536	322	15.8	7.81	4.57	.39
Extra standards	1,018	875	545	333	18.1	7.90	6.75	.37
Extra	1,030	890	507	383	21.5	8.00	10.4	.35
Special extra	1,045	905	562	343	23.7	.....	.....	.....

Effect of varying degrees of sirup on Royal Anne cherries. (Weight of fruit, 540 grams, No. 2½ can; examined July 1, 1912, Oct. 1, 1912, and Mar. 15, 1914.)

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	1,010	870	530	340	10.5	6.00	0.71	0.33
	975	835	540	295	10.3	4.5	2.14	.34
	970	830	495	335	10.0	7.90	.00	.39
10	1,020	880	495	385	16.00	9.50	2.14	.34
	990	850	492	357	16.5	9.50	2.38	.33
	1,015	875	490	385	18.3	11.82	3.44	.36
20	1,020	880	495	385	21.3	10.50	5.70	.37
	1,045	905	505	400	21.5	10.00	6.41	.34
	1,050	910	470	440	26.2	10.5	11.16	.33
30	1,070	930	475	455	26.6	10.0	11.88	.33
	1,040	900	490	410	23.7	15.66	5.40	.37
	1,060	920	440	480	31.6	10.50	16.62	.37
40	1,070	930	445	485	32.2	12.25	14.49	.33
	1,070	930	460	470	32.2	18.92	11.32	.36
	1,080	940	410	530	36.4	13.75	19.71	.34
50	1,080	940	400	540	37.7	12.75	17.81	.35
	1,070	930	440	490	37.5	20.36	14.36	.36
60	1,090	950	380	570	40.5	11.0	23.75	.37
	1,105	965	415	550	40.6	12.5	23.28	.33

Effect of varying degrees of sirup on cherries. (Weight of fruit: Royal Anne, 550 grams; Rockport, 550 grams; Tartarian, 520 grams; examined June 2, 1913, July 2, 1913, and Jan. 17, 1914.)

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Water:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams. per 100 cc.*	*Grams per 100 cc.*
Tartarian	975	835	535	300	10.4	6.25	0.70	0.35
	975	835	525	310	9.7	6.25	.47	.32
	980	840	535	305	10.1	7.12	.21	.31
Rockport	970	830	550	280	8.6	4.5	.47	.19
	960	820	510	310	10.3	7.20	.10	.19
Royal Anne	985	845	565	280	10.3	7.0	.00	.38
	975	835	555	280	10.4	7.0	.00	.33
10:	975	835	560	275	10.8	7.11	.36	.31
Tartarian	970	830	530	300	14.6	7.5	4.27	.32
	995	855	525	330	13.6	7.75	2.85	.30
	1,000	860	530	330	13.85	7.57	3.92	.27
Rockport	960	820	530	290	13.6	3.75	7.12	.18
Royal Anne	995	855	.....	.....	14.3	6.50	5.23	.36
	995	855	.....	.....	15.3	8.50	3.09	.36
	985	845	530	315	14.2	10.00	.26	.33
20:	1,000	860	510	350	18.0	6.0	7.36	.31
Tartarian	1,005	865	510	355	18.4	7.50	5.94	.30
	1,010	870	525	345	19.1	9.50	6.61	.33
Rockport	985	845	525	320	19.70	2.75	14.25	.15
	990	850	525	325	17.4	8.22	6.57	.21
Royal Anne	1,005	865	525	340	18.5	6.5	9.26	.33
	1,005	865	510	355	18.9	8.75	7.13	.33
	1,005	865	520	345	18.2	11.74	4.03	.31
30:	1,030	890	475	415	23.5	4.5	14.25	.30
Tartarian	1,020	880	490	390	23.2	4.5	14.25	.30
	1,035	895	505	390	23.3	10.54	10.18	.26
Rockport	1,000	860	500	360	25.6	1.75	20.90	.13
	1,000	860	505	355	21.9	9.44	9.56	.18
Royal Anne	1,025	885	510	375	22.7	6.25	12.59	.34
	1,010	870	540	330	21.5	8.50	9.74	.34
	1,015	875	540	335	22.1	10.10	9.56	.32
40:	1,030	890	425	465	28.3	4.75	18.29	.30
Tartarian	1,025	885	465	420	27.2	6.50	16.39	.30
	1,035	895	485	410	28.2	13.72	12.20	.28
Rockport	1,015	875	475	400	30.9	3.00	23.75	.12
	1,015	875	490	385	26.8	10.08	14.59	.16
Royal Anne	1,030	890	495	395	26.6	8.00	14.73	.29
	1,025	885	510	375	25.7	11.32	11.82	.32

Effect of varying degrees of sirup on cherries. (*Weight of fruit: Royal Anne, 550 grams; Rockport, 550 grams; Tartarian, 520 grams; examined June 2, 1913, July 2, 1913, and Jan. 17, 1914*)—Continued.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
50:								
Tartarian	1,040	900	405	495	35.4	4.75	27.79	0.24
	1,050	910	415	495	32.3	6.25	21.61	.29
	1,060	920	470	450	32.25	12.13	18.06	.28
Royal Anne	1,040	900	415	485	33.1	6.5	23.28	.30
	1,050	910	460	450	32.9	8.50	19.95	.33
	1,040	900	490	410	31.5	13.95	.....	.32
60:								
Tartarian	1,040	900	385	515	40.2	3.5	30.88	.23
	1,060	920	385	535	37.4	8.00	25.65	.31
	1,055	915	450	465	36.1	12.92	20.86	.30
Royal Anne	1,060	920	390	530	39.6	6.0	30.67	.29
	1,065	925	415	510	37.3	7.75	25.41	.28

The cut-out appearance of a can of cherries, containing 560 grams of fruit, but packed in varying sirups, showed the following fill: Water-packed lacked one-half inch; 10° sirup, slightly more than one-half inch; 30° sirup, 1 inch; 40° sirup, 1¼ inches; 50° sirup, two-thirds full; and 60° sirup, about half full. When using 400 grams and water the cans lacked 1¼ inches; 450 grams, 1 inch; 500 grams, three-fourths inch; 550 grams, one-half inch; and 600 grams, one-fourth inch. In the commercially packed cherries, the extras lacked 1 inch; extra standard and standard, three-fourths inch; and seconds and water, 1¼ inches of being full after draining. The practice in packing cherries has been to use from 18.5 to 19 ounces in the can. During 1913, however, most of the packers increased their weights to 20 ounces, and some to 21 and 22 ounces, many springers being produced in the latter.

Currants (Ribes rubrum).

The currant is not canned except for stock for jelly or for mixing with other fruits to give flavor. When it is packed, it is usually put in glass or stoneware jars. It has been included in this work for comparative purposes.

Effect of varying degrees of sirup on currants. (*Weight of fruit, 360 grams for a No. 2 can; examined Oct. 8, 1912, and Apr. 18, 1913.*)

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
10	695	595	260	335	11.6	7.75	0.47	1.14
	690	590	287	303	11.9	8.62	.12	1.23
20	705	605	290	315	16.2	10.75	1.66	1.42
	705	605	277	323	16.6	12.37	.00	1.26
30	740	640	255	385	23.4	12.00	7.36	1.07
	727	627	272	355	22.4	17.37	.60	1.21
50	740	640	240	400	31.8	19.00	9.02	1.18
	755	655	300	355	29.0	22.25	2.14	1.26
60	740	640	235	405	35.0	20.00	9.50	1.22

In all cases when the currants were unstemmed, springers and swells were produced within three months, and when stemmed the time was extended to from seven to nine months. This was not due to bacterial action. The swell was so strong as to cause the can to break in some cases. They did not pinhole as was expected. Not a single can escaped swelling and only a few were held for more than one year.

Gooseberries (Ribes grossularia).

Few gooseberries are canned, and these are largely used for pies. The berries are gathered when nearly ripe and are handled in baskets and shallow boxes. The first operation at the factory is to remove the stems and brown blossom ends. This was

done formerly by running them over a vibrating screen upon which was directed a strong blast of air. This removed part of the blossoms and stems, and the remainder were either rubbed off by hand or were passed with the fruit. An improved gooseberry cleaner consists of a slitted disk, below which parallel knives revolve. The berries are poured above the disk and made to roll over and over by light dragging chains. This causes the stem or blossom to fall into the slits, where they are cut off close to the berry. The berries are then washed and filled into cans by weight. Those intended for pies usually have only water added, while those for the general trade have a sirup. The filling, exhausting, and capping are the same as for other berries.

Effect of varying degrees of sirup on gooseberries. (Weight of fruit, 500 grams, No. 2½ can; examined June 3, 1913, July 3, 1913, and Jan. 22, 1914.)

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	965	825	465	360	5.3	3.00	0.0	1.26
	965	825	465	360	5.5	3.00	.0	1.30
	960	820	505	315	5.5	2.37	.04	1.36
10	1,000	860	465	395	10.2	3.00	5.22	1.17
	995	855	475	380	10.4	5.00	2.38	1.30
	990	850	480	370	10.5	7.30	.57	1.39
20	1,000	860	455	405	14.8	4.5	8.07	1.12
	1,000	860	465	395	14.4	7.50	4.27	1.23
	1,000	860	480	380	14.7	11.18	.70	1.39
30	1,000	860	450	410	21.8	7.25	8.55	1.00
	1,015	875	475	400	19.6	7.50	7.84	1.26
40	1,020	880	455	425	27.9	6.25	14.49	.83
	1,025	885	465	420	23.9	10.00	9.50	1.26
50	1,050	910	430	480	35.2	7.00	22.8	.82
	1,045	905	450	455	30.0	12.50	12.83	1.26
	1,070	930	440	490	44.0	6.50	33.25	.76
60	1,065	925	440	485	36.5	8.75	23.61	1.22
	1,065	925	495	430	35.5	27.44	4.20	1.64

Grapes (Vitis vinifera).

Grapes have not been used very extensively in canning, but there has been a noticeable increase in the pack in the last few years. The white grapes are preferred for this purpose, as the colored grapes lose color to such an extent that they become unattractive. The grapes are gathered in standard boxes or baskets as for the market. The clusters are selected when the flavor is well developed but the fruit fairly firm. The stemming is done by hand, and in California it is the general practice to grade to size by passing them over screens having holes 20, 21, 24, and 26 thirty-seconds of an inch in diameter. The fruit is washed and the cans filled to within one-fourth inch of the top and a hot sirup added. After exhausting, a process of 212° F. is given for 14 minutes.

Effect of varying degrees of sirup on grapes. (Weight of fruit, 550 grams; examined Oct. 12, 1912, Apr. 25, 1913, and Mar. 3, 1914.)

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	985	845	425	420	11.3	8.25	0.00	0.54
	1,005	865	415	450	12.7	9.50	.00	.52
	1,000	860	435	425	12.5	11.18	.00	.37
20	1,025	885	420	465	20.8	13.50	5.12	.31
	1,022	882	412	470	21.2	15.00	2.61	.38
	1,022	882	440	442	21.3	18.28	1.75	.37
30	1,042	902	407	495	23.7	12.37	9.61	.31
	1,045	905	405	500	24.3	15.5	5.23	.38
	1,055	915	435	480	24.0	21.54	1.12	.37

Effect of varying the weight of fruit.

Weight of fruit (grams).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.
	Grams.	*Grams.*	*Grams.*	*Grams.*
450	900	760	355	405
550	980	840	405	435
600	1,015	875	455	420

The foregoing experiments were made with Muscat grapes, and examinations of the commercial pack from these sources gave similar results.

Loganberries.

The loganberry is the result of an accidental cross of a wild blackberry and a raspberry, made by Mr. J. H. Logan at Santa Cruz, Cal., in 1881. It is grown in a very limited way in various parts of the United States, but for canning purposes only on the Pacific coast. It resembles a large blackberry in size, is red in color, and has a distinctive flavor of both the blackberry and the raspberry. It is grown and harvested in the same manner as the blackberry. It is one of the fruits that most persons find improved by cooking. It is very acid and needs a heavy sirup. Because of the limited supply and the difficulty of keeping them in the ordinary can, only a few are packed. They bleach badly and cause pin holes, with resultant spoilage. The best results are obtained with inside-laquered cans, but even these will not keep them in good condition for more than a few months.

Effect of varying degrees of sirup on loganberries and the cut-out sirup.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
1. Weight of fruit, 360 grams; No. 2 can, examined Oct. 8, 1912, Apr. 18, 1913, and Apr. 4, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	667	567	287	280	6.1	3.62	0.47	1.33
	670	570	295	275	5.9	3.25	.00	1.23
	675	575	245	330	5.9	3.06	.00	1.28
10	680	580	300	280	12.3	8.50	1.67	1.27
	685	585	295	290	12.4	9.62	.00	1.25
	718	618	253	365	22.5	16.37	3.09	1.11
30	710	610	255	355	21.4	16.25	1.43	1.16
	720	620	260	360	21.6	19.28	.00	1.20
40	693	593	303	290	28.6	19.66	5.35	1.26
	693	593	291	302	28.0	19.94	4.51	1.26
	737	637	232	405	32.9	21.87	8.19	1.21
50	735	635	241	394	32.2	23.87	3.92	1.15
	740	640	255	385	32.5	29.88	.08	1.21
	750	650	237	413	37.9	23.00	11.16	1.18
60	755	655	255	400	38.0	24.00	9.97	1.22
	745	645	280	365	38.0	34.78	1.01	1.15
2. Weight of fruit, 550 grams; pack of 1913, examined June 17, 1913, July 18, 1913, and Jan. 25, 1914:								
	965	825	475	350	6.8	4.25	.00	1.38
Water	960	820	445	375	7.4	4.5	.24	1.51
	950	810	430	380	7.0	3.19	.00	1.52
	970	830	485	345	10.5	6.0	2.14	1.38
10	970	830	470	360	10.5	5.75	2.14	1.51
	975	835	460	375	10.8	6.41	.45	1.52
	990	850	450	400	14.4	6.5	5.28	1.38
20	985	845	450	395	14.2	8.75	2.14	1.49
	990	850	465	395	14.3	9.69	.76	1.60
	1,000	860	425	435	19.2	8.75	9.02	1.32
30	1,000	860	455	405	19.7	10.5	6.65	1.38
	995	855	455	400	19.8	14.0	1.50	1.48
	1,020	880	385	495	26.2	11.75	11.64	1.07
40	1,020	880	420	460	24.6	14.75	7.13	1.47
	1,020	880	475	405	25.3	19.17	2.22	1.45
	1,015	875	375	500	30.5	11.75	16.25	1.01
50	1,030	890	425	465	27.7	13.75	11.64	1.39
	1,025	885	480	405	28.1	21.1	3.58	1.47
	1,040	900	380	520	36.3	13.0	19.95	.92
60	1,040	900	385	515	32.4	13.25	14.95	1.39
	1,040	900	465	435	31.8	24.85	3.87	1.50

The finished product is graded the same as the blackberry. The shrinkage is somewhat greater and the berries mat together more. In the experiments the fruit packed in water, 10°, 20°, and 30° sirup showed more shrinkage and softening and disintegrated more in shipping than that packed in the higher sirups. The 50° sirup gave the best results in appearance, but the 60° produced the best flavor.

Peaches (Prunus persica).

The peach is probably the most popular fruit canned, and the quantity so used is enormous. It leads all other fruits in value. The principal packing is done in California, New York, and Michigan. The conditions for growth are so favorable on the western coast, and peaches acquire such size that they are purchased on the basis of being 2¼ inches or more in diameter, those below that size being received at a reduced price. The eastern packers can not make such close discrimination. A number of varieties are used, but practically all are grouped as cling, or lemon cling, and freestone. The cling is the favorite in the West, and the freestone in the East. The term "lemon cling" really refers to a nearly extinct variety, and in the future labels will read "yellow cling."

The growing, picking, and handling are the same as for the market. The picking is done by hand and should take place just when the peach is beginning to turn soft. The flavor should be clearly developed, for it will not develop after the fruit leaves the tree. The delivery to the factory is made in the standard box, and, while the necessity for prompt working is not so great as with berries, the peach, if ripe, can not safely stand for more than two or three days. In case of a rush, it may be held in cold storage for a few days, but at the sacrifice of quality.

At the factory the method of procedure depends upon the manner in which the peeling is done, whether by hand or by lye. If the lye-peeling system is used, the boxes of peaches are delivered to the pitters. As the peaches are pitted, they are placed in other boxes and there may or may not be an attempt at some grading for quality. The grading for size occurs later. It is at this point in the work that decided improvement could be made. The trucking of boxes of peaches into the factory and empty boxes and boxes of pits out is not conducive to a clean floor. The handling of the pitted peaches in numerous small boxes, while it may be clean, and in most cases is clean, is not in line with sanitary methods. Wooden boxes become foul with cut fruit and can not be easily cleaned. Trucking back and forth in the factory is not the best nor the easiest way to convey the fruit. Moreover, there is a tendency to allow some split fruit to stand for an unnecessary length of time.

The real work should begin by demanding that graded fruit be brought to the factory, or by emptying the box of peaches upon a conveyer and having a few persons remove the green and defective fruit before it reaches the pitters. The 5, 10, or 12 per cent which will not make the better grades should be taken out at the start and worked separately. This will relieve the pitters of part of their work, relieve the fillers of part of their inspection, and prevent holding up such fruit for a long time after it is split. A part of it will not be worth using, and labor all along the line will be saved. It is the first step in right grading. The objection urged is that it makes one more handling and causes bruising of fruit. A single conveyer system could easily be designed to carry the peaches to the pitters, and from the pitters to the peeling machine, thus eliminating the box system and trucking. It can be made decidedly more cleanly, and cleanliness is necessary in every step of factory work. While none of the fruit or refuse which falls upon the floor in trucking comes in contact with the fruit to be eaten, it does not look well and is conducive to carelessness in other operations. Strict cleanliness can be enforced only by making all parts clean, whether they come in contact with the food or not, and a factory can not be graded as sanitary while any part is unclean.

If the peaches be hand peeled, the fruit may or may not be graded for size first, and the subsequent conveying to the pitters and peelers may be in boxes. The difference is that the peelers have more waste to handle, but, owing to the preliminary grading, they do not have more than two pans into which to divide their fruit. The method itself makes it necessary to handle the fruit promptly to avoid discoloration. The conveying of the fruit to the pitters and of the waste and the peeled peaches to the blancher is subject to the same criticism as in the other system.

If a freestone, the peach is split around the line of the pit mark and the halves easily torn apart by a slight circular motion; if a cling, the pitting scoop is inserted close to the pit, cutting it free from one side, then scooping it out from the opposite half. The scoop is held close to the pit to avoid waste or marking the fruit. If the peach is hand-peeled, a curved knife having a guard is used, the halves being handled separately after the pitting. With a very few varieties of eastern freestones, the peeling is done by slipping the skins. This is accomplished by placing the halves, pit side down, on a tray which has been covered with cheesecloth. The cloth is then folded over the fruit and the tray placed in a steam box for about three minutes. The skin can then be lifted by picking it up at one edge. The pieces are immediately put in a can and the desired sirup added.

When hand peeling is practiced, it is the usual custom to blanch the peaches in hot water to make them more flexible for placing in the can and to remove any browning effect from the oxidase. The peaches neither gain nor lose appreciably in the blanch, as the variation on 25-pound lots by this treatment amounted to only about 4 ounces, and might be an increase or decrease. It makes it possible to pack from one-half to 1½ ounces more in a can than when blanching is not practiced. The cans are filled according to the size of the pieces, the off quality and the defective being separated for a lower grade. The sirup selected will vary according to the grade packed.

Where lye peeling is followed, the halves are passed through a machine containing a strong, hot solution of caustic soda. The amount of soda used is from 1 to 2¼ pounds a gallon, strong enough to instantly cauterize the tissue with which it comes in contact. The time required for the fruit to pass through the solution is from 18 to 25 seconds, the object being to prevent the solution from penetrating the tissue. As soon as the peaches emerge they are struck with streams of water under strong pressure, which has the effect of instantly cutting off the cauterized portion. Dropping the fruit in a tank of water or under streams with weak pressure is not effective. The strong, sharp spray is very essential. The halves are next passed over grading screens having holes 64, 68, 72, and 76 thirty-seconds of an inch in size, which, with those that pass over the end, give five sizes. Automatic conveyers carry the different grades to the filling tables. The peaches are washed on the way to the grader, while they are on the grader, and are kept in water on the filling tables. By far the larger proportion of peaches are lye-peeled. Each method has its advantages and disadvantages, but in either case more depends upon the packer and the quality of the fruit used than upon the method employed.

The cans are filled by hand, the quantity being made to equal or exceed a certain number of ounces. The present method is to fill trays of one dozen cans, which are carried or trucked to the filling machine. This can easily be improved upon by the use of a conveyer. Sirup of the desired degree is added, the can exhausted for three minutes, sealed, and processed for from 12 to 20 minutes at 212° F.

The waste in canning peaches consists in pits, peels, and trimmings. The pits are dried, and in some places used for fuel, or they are shipped abroad for manufacture into oil. The table waste is sent to the brandy distillery if one be near. The waste from pits is about 16 per cent and from hand peeling about 33 to 35 per cent.

The effect of varying degrees of sirup upon peaches is not marked unless the fruit is very ripe. If overripe, the fruit breaks down and the sirup can not be drained uni-

formly. The results of experimental packing and of examinations of the commercially packed article are shown in the following tables:

Effect of varying degrees of sirup upon peaches and the "cut-out" sirup.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
1. Weight of fruit, 560 grams; hand-peeled; pack of 1912; examined Oct. 24, 1912, and May 16, 1913:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams. per 100 cc.*	*Grams per 100 cc.*
Water	970	830	550	280	9.3	2.50	4.75	0.41
	965	825	520	305	8.4	3.00	1.90	.31
20	1,000	860	545	315	17.4	2.75	11.16	.43
30	1,015	875	545	330	20.2	4.25	11.40	.35
	1,025	885	545	340	20.4	6.00	10.24	.38
40	1,032	892	565	327	23.9	5.00	14.96	.65
	1,031	891	551	340	24.8	8.25	9.97	.50
50	1,047	907	545	362	30.0	4.75	19.50	.48
	1,041	901	552	349	29.3	7.89	14.84	.47
60	1,057	912	517	395	33.4	5.12	21.73	.48
	1,052	912	512	400	34.0	7.62	21.50	.48
2. Weight of fruit, 560 grams; lye-peeled; pack of 1913; examined Aug. 12, 1913, Sept. 25, 1913, and Mar. 25, 1914:								
Water	955	815	535	280	8.4	3.25	2.14	.48
					8.4	3.35	2.04	.50
	975	835	525	310	9.6	3.92	2.77	.48
10					11.2	3.25	4.75	.47
	965	825	480	325	11.4	3.75	4.12	.44
					15.4	3.25	8.55	.42
20	985	845	545	300	15.0	3.75	9.02	.50
	995	855	565	290	15.9	5.82	7.13	.47
					17.4	3.25	10.45	.45
30	995	855	530	325	18.0	4.50	10.93	.48
	995	855	570	280	18.8	6.30	9.22	.44
					22.0	3.00	15.20	.44
40	1,015	875	535	340	22.4	4.25	14.72	.48
	1,020	880	565	315	21.9	7.22	11.70	.47
	1,020	980	540	340	27.8	2.50	21.85	.38
50					26.3	3.75	19.24	.48
	1,010	970	530	325	26.3	8.44	15.07	.44

Weight of fruit and compositions of sirup in commercially canned peaches.

Grade of fruit and density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Extra special, 55° sirup:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Average	1,034	893	494	399	26.1	4.29	17.89	0.40
Highest	1,075	935	585	525	32.6	5.75	24.95	.59
Lowest	1,000	860	410	290	21.4	3.00	11.88	.21
Extra, 40° sirup:								
Average	1,015	870	503	367	22.2	3.80	14.93	.43
Highest	1,040	900	570	420	24.0	4.74	17.57	.77
Lowest	990	840	440	310	19.6	2.50	12.59	.25
Extra standard, 30° sirup:								
Average	996	858	515	345	18.5	3.81	11.59	.40
Highest	1,020	880	580	410	21.8	5.75	15.91	.54
Lowest	980	840	440	265	17.0	2.50	8.08	.28
Standard, 20° sirup:								
Average	977	837	506	331	16.1	3.50	9.30	.41
Highest	1,000	860	625	400	19.0	5.25	11.64	.54
Lowest	945	805	410	220	13.3	2.75	6.65	.24
Seconds, 10° sirup:								
Average	958	818	516	302	12.3	2.94	6.26	.36
Highest	980	850	560	385	15.4	4.00	9.03	.44
Lowest	900	760	425	265	9.6	2.00	3.80	.27
Water:								
Average	947	807	514	293	9.0	2.61	4.15	.36
Highest	980	840	625	370	13.7	3.50	9.02	.55
Lowest	910	770	425	215	6.0	1.00	.95	.21

Since the peach is the most popular fruit canned, is reasonably stable, and presents an attractive appearance, it is but natural that it should be more closely graded than any other. Unfortunately, the grading is done chiefly for jobbing purposes and not for the benefit of the consumer. The appearance of the peach in the cut-out depends upon the stage of ripeness and the variety. Varieties having very large pits produce rather thin, flat pieces, though they may be large in circumference, while varieties having small pits are thick. The greener and harder the fruit, the more symmetrical the pieces and the sharper the edges. The very best fruit is inclined to become extremely tender and soften sufficiently to flatten out, to lose its clean-cut edges, and to have particles break off and become free in the sirup. Selection for the highest grades is made at the stage when the fruit does not quite soften in the handling, and when the firm, sharp edges and brilliant color give a most attractive appearance. The peach in its prime condition for canning does not undergo nearly so much shrinkage as the apricot. Most of the apparent slackness in fill is due to the softening, which allows pieces to settle together to a greater or less extent. Prime peaches packed in water, 10°, 20°, or 30° sirup will show a fill to within three-fourths of an inch of the top; in 40° sirup to about 1 inch; and in 50° or 60° sirup only slightly less. If the fruit be soft-ripe, the shrinkage will be more.

Sliced peaches are packed in the same grades as the halves, and the stock and sirup used must correspond to the same quality. Melba peaches are selected perfect peaches, packed whole. They are packed one, three, or four, the cans being made of the required height. The sirup is usually 40° or 55°. The finding of peaches which have turned pink or have sirup of a pink color is usually due to the use of sunburned fruit or to the fruit having remained hot for a long time. In neither case has the injury been found to extend further than the appearance.

Pears (Pyrus communis).

The pears used in canning may be grouped into two classes, hard and soft, the former being represented by the Kiefer and the latter by the Bartlett. Other varieties represent a very small part of the pack. The Bartlett is much the best pear for canning purposes and is probably used for nearly three-fourths of the entire pack. The pears are hand-picked just before they are ready to turn soft and are delivered to the factory in boxes of a standard size. The fruit is delivered promptly and worked up before it has time to soften sufficiently to injure the appearance in handling. If it be necessary to hold them for a week or more, they are placed in cold storage. The pears are not graded for size but are delivered to the peelers in boxes. No machine work is used in the peeling, all work being done by hand. The knife used has a curved blade, surmounted by a guard to limit the amount of peel taken off. The peel is removed from the blossom end to the stem end, instead of around the fruit, care being taken to preserve a symmetrical appearance. The fruit is then split in halves, and a special coring scoop is used to remove the blossom end, core, and stem. The matter of peeling and coring is distinctly important in the production of high-grade goods, as appearance is regarded with the same care as quality. No bruise marks, pieces cut out, or split pieces are permissible in extra standard or extra goods, and only an occasional piece in the standard. As soon as possible after peeling the pears are placed in cold water to prevent their turning brown. If it should be necessary for any reason to hold them for some time, a small quantity (about 1½ ounces to the gallon) of salt may be added, as it will lessen the action of the oxidase. The waste from pears in the form of skins and cores amounts to from 30 to 35 per cent. Only a small part is used for brandy, the remainder being discarded as waste.

The peelers make a partial separation of the pears into four sizes when they place the halves in pans, the grading being wholly by the eye. Those who fill the cans carry the work further and correct "off sizes," separating the defective and green

pieces from the better grades. The work of packing, which is wholly by hand, requires somewhat skillful adjustment of the pieces to secure full weight. All cans are weighed and packed as close to the weight selected as the size of the pieces will admit. The three grades, standards, seconds, and water, are filled without layering, which accounts in some measure for the lower weight, though anything under 500 grams in these grades should be regarded as "slack filled."

Pears, not being particularly acid or juicy, do not require a very heavy sirup. The flavor is impaired rather than improved when more than 25° sirup is used, and the higher sirups found in the special extra and extra grades are more for jobbing purposes in the trade than for real quality. After the hot sirup has been added, the cans are exhausted, then processed in an open bath for from 10 to 20 minutes.

An experiment was made to determine the effect of allowing the peeled pear to stand. In the factories it is not unusual for quantities of certain grades to accumulate and be held for an hour or more in the cans. In the experiment pears were allowed to stand one, two, three, and four hours. They were then exhausted and processed in the usual way. The effect was that some of the more delicate cells on the surface would dry out, so that after processing a more or less pitted appearance was given. The depth and size of these pits increased on standing. It was also found that during the processing a certain part of the tissue in these pits was loosened and floated in the sirup, giving a decided turbidity. This points very clearly to the necessity for rapid action in order to secure the bright, clean sirup so desirable for pears.

The color and the texture of the pear make it especially valuable in studying the effect of exhausting. A well-canned pear should have a clean, bright color, but a semitranslucent body showing quite clearly the fibro-vascular structure. The dead white or hard chalky appearance is decidedly objectionable. Properly matured pears, when given a quick, hard exhaust, which heated only the outside, retained this dead white appearance, whatever the process given. Pears given a slow exhaust at a lower temperature, but taking time for the heat to penetrate through the pieces gave the desired effect each time. High, quick heating also produced more turbidity of the sirup than longer heating at a lower temperature.

Effect of varying degrees of sirup upon pears and the "cut-out" sirup.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Bartlett; weight of fruit, 560 grams; examined Oct. 17, 1912, Apr. 7, 1913, Apr. 2, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	965	825	568	267	11.2	5.50	1.90	0.14
	970	830	560	270	11.0	4.75	2.13	.16
	965	825	565	260	10.8	6.14	.68	.16
10	975	835	575	260	12.8	4.25	4.38	.15
	980	840	560	280	14.4	4.00	5.58	.14
	975	835	560	275	13.7	6.12	4.16	.13
20	995	855	568	287	16.1	4.87	6.77	.14
	975	835	542	293	16.6	4.00	8.64	.13
	1,000	860	535	325	16.6	6.24	7.22	.12
30	997	857	557	307	19.8	4.87	10.73	.13
	990	850	545	305	20.2	4.25	11.26	.13
	1,005	865	530	335	21.5	7.28	11.15	.13
40	1,020	880	565	315	24.5	5.00	15.20	.14
	1,030	890	572	318	25.0	5.25	15.20	.13
	1,030	890	595	295	25.4	8.24	13.32	.12
50	1,035	895	540	355	27.5	5.25	17.10	.14
	1,035	895	550	345	27.0	4.50	16.86	.13
	1,050	910	555	355	27.2	7.64	16.59	.12
60	1,055	915	560	355	30.8	4.75	22.56	.11
	1,055	915	570	345	31.2	5.12	21.48	.14
	1,065	925	.....	.....	30.9	9.98	11.77	.12

Effect of varying degrees of sirup upon pears and the "cut-out" sirup—Continued.

Density of sirup (degrees).	Gross Weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Pack of 1913; weight of fruit, 550 grams; examined Aug. 7, 1913, Sept. 23, 1913, Feb. 4, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water [1]	950	810	580	230	9.3	5.25	0.00	0.15
Water [2]	940	800	570	230	8.1	4.50	.00	.14
10	955	815	550	265	11.9	5.00	4.27	.14
	950	810	540	270	12.4	6.75	2.85	.16
	950	810	590	220	12.6	9.38	.21	.22
20	980	840	560	280	15.2	4.50	7.60	.14
	985	845	555	290	15.5	6.00	6.18	.16
	980	840	590	250	15.5	8.91	3.29	.21
30	1,000	860	540	320	21.6	3.75	14.49	.13
	990	850	555	295	20.6	4.5	12.11	.14
	1,000	860	565	295	21.5	6.06	12.24	.17
40	1,000	860	550	310	25.5	3.25	19.47	.11
	995	855	565	290	24.4	4.00	16.39	.14
	1,010	870	595	275	25.1	7.12	14.50	.16
50	1,015	875	485	390	30.5	3.25	23.99	.11
	1,000	860	515	345	27.9	5.25	18.76	.....

[1] Tree-ripened; tender. [2] Ripened in the laboratory; decidedly hard.

Average weight and composition of commercially-packed pears.

Grade of fruit and density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of solids.	Weight of sirup.	Brix reading.	Invert sugar.	Sucrose.	Acidity.
Special extra, 40° sirup:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Average	1,000	865	518	346	24.1	4.00	15.75	0.12
Highest	1,025	885	600	415	25.2	4.50	17.81	.13
Lowest	980	840	455	285	23.0	3.25	14.50	.11
Extra, 30° sirup:								
Average	1,009	875	531	339	17.9	4.25	10.18	.11
Highest	1,050	910	610	390	22.2	5.00	13.77	.15
Lowest	980	840	480	290	14.4	3.00	5.22	.09
Extra standard, 20° sirup:								
Average	982	841	531	310	16.6	4.47	8.45	.13
Highest	1,015	875	615	375	19.8	5.50	11.40	.15
Lowest	900	760	500	235	15.8	2.75	6.41	.08
Standard, 15° sirup:								
Average	970	829	521	306	14.3	4.00	6.91	.13
Highest	1,000	860	570	340	15.8	5.00	9.00	.16
Lowest	915	775	475	275	13.4	2.75	4.99	.09
Seconds, 10° sirup:								
Average	969	829	511	318	12.9	3.84	5.07	.11
Highest	1,000	860	545	360	14.7	4.50	7.13	.13
Lowest	940	800	480	280	11.2	2.75	2.85	.10
Water-packed:								
Average	951	811	501	311	9.3	4.25	1.99	.12
Highest	1,070	930	540	390	10.8	4.75	3.09	.15
Lowest	845	705	415	235	8.1	3.75	.43	.10

Though it may be tender, the pear has sufficient strength to maintain a very nearly normal shape and size. It is only in the heavier sirups that appreciable shrinkage occurs. It is therefore graded by the number of pieces to the can, their symmetry, texture, and color. The first three grades must be evenly matured, ripe, but not soft, and they must be nicely peeled, cored, and split equally, have good shape, fine texture, and be free from pink color. Pink pears are due to the use of imperfectly developed fruit, to fruit becoming overheated, as in a car, and to remaining hot for too long a time after processing. The difference in the condition of imperfectly developed

and overheated fruit is easily determined under the microscope. In the former case it is rare to have more than one or two pieces in a can, and then only in occasional cans. When due to prolonged heating, more pieces and cans show this defect in appearance.

Plums (Prunus domestica).

Several varieties of plums are used in canning, the popular ones being the green gage, the yellow egg, and the Lombard. The fruit is gathered just as it is beginning to turn soft, and the preliminary treatment is the same as for apricots. The California plums are graded for size, being run over screens having openings 32, 40, 48, and 56 thirty-seconds of an inch in diameter. They are washed, and the imperfect or spotted fruit picked out; ordinarily the plum is not peeled. The cans are then filled, some care being necessary in placing the plums so that the fill will be uniform. Hot sirup is added, and the cans processed at 212° F. for from 8 to 14 minutes.

Effect of varying degrees of sirup on green gage and yellow egg plums.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Green gage plums; weight of fruit, 350 grams, No. 2 can; examined Oct. 23, 1912, Apr. 11, 1913, Mar. 26, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	695	595	328	267	8.9	4.00	1.54	0.90
	685	585	305	280	8.9	4.87	.13	.93
	690	590	390	200	9.3	5.48	.01	.91
10	700	600	335	265	13.4	7.75	1.43	.94
	700	600	330	270	13.7	7.87	1.54	.88
	700	600	340	260	13.3	9.20	.14	.92
20	705	605	330	275	16.8	8.37	4.63	.92
	707	607	335	272	16.5	10.75	1.19	.91
	690	590	340	250	16.7	12.23	.29	.92
30	712	612	327	285	21.2	10.75	7.50	.93
	715	615	330	285	22.4	13.00	4.63	.85
	725	625	335	290	22.1	17.38	.79	.82
40	735	635	320	315	26.9	11.87	10.80	.91
	730	630	320	310	27.0	17.00	5.70	.86
	730	630	350	280	26.5	22.76	.20	.91
50	742	642	305	337	32.4	16.75	13.06	.83
	737	637	305	382	32.8	23.75	2.14	.92
	755	655	360	290	31.8	26.25	1.13	.88
60	755	655	307	348	36.6	16.51	16.51	.85
	755	655	310	345	37.6	22.00	10.93	.78
	760	660	345	315	36.4	30.90	2.02	.92
Yellow egg plums; weight of fruit, 560 grams, No. 2½ can:								
Water	1,010	870	540	330	10.6	5.25	.00	1.24
	1,002	862	525	337	10.3	5.37	.36	1.24
	1,040	900	595	325	14.1	5.25	2.14	1.42
10	1,022	882	575	307	14.5	7.25	.71	1.38
	1,040	900	625	275	15.9	10.54	.00	1.37
	1,035	895	575	320	16.3	10.00	.71	1.31
20	1,037	897	572	325	16.2	10.5	.48	1.19
	1,035	895	600	295	16.8	11.94	.00	1.29
	1,040	900	575	325	22.0	9.75	5.94	.93
30	1,035	895	580	315	21.4	12.5	5.23	1.19
	1,035	895	595	300	21.9	17.90	.17	.80
	1,065	925	530	395	25.5	17.75	3.56	.79
40	1,050	910	570	340	25.9	22.10	.00	.88
	1,060	920	475	445	31.4	13.00	9.97	.76
	1,047	907	507	400	30.2	21.75	.71	.79
50	1,065	925	510	415	31.6	29.22	.00	.76
Green gage plums, 30° sirup:								
400 grams	982	842	335	507	24.0	12.0	8.77	.67
450 grams	997	857	402	455	22.5	11.2	9.03	.83
500 grams	1,060	920	430	490	22.8	12.5	5.22	.84
550 grams [1]	1,030	890	375	575	21.0	9.0	8.82	.98

[1] Fruit, crushed, would not drain properly.

Effect of varying degrees of sirup on green gage and yellow egg plums—Continued.

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Washington plums; weight of fruit, 550 grams; examined Aug. 6, 1913, Sept. 22, 1913, Apr. 14, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	995	855	480	375	10.4	4.50	0.47	1.01
	985	845	445	400	11.7	6.5	.00	1.17
	990	850	495	355	12.6	6.70	.44	1.22
10	1,000	860	440	420	14.9	5.75	4.04	.94
	980	840	430	410	15.3	8.75	1.66	1.18
	970	830	500	330	16.5	9.24	1.10	1.23
20	1,025	885	445	440	18.6	6.00	8.55	.93
	1,030	890	425	465	18.4	8.75	5.36	1.16
	1,045	905	495	410	25.5	6.50	15.20	.76
30	1,035	895	505	390	23.0	10.75	8.79	1.11
	1,035	895	535	360	24.1	15.04	4.57	1.07
	[1]1,050	910	440	470	34.0	8.25	20.90	.78
40	1,045	905	440	465	30.4	11.75	14.96	1.01
	1,040	900	480	420	30.5	24.60	2.09	1.09
	1,055	915	395	520	34.3	9.25	20.19	.79
50	1,040	900	425	475	33.2	12.75	15.44	.92
	1,050	910	490	420	32.2	23.10	4.83	1.07
	[1]1,065	925	410	515	45.3	8.75	32.06	.69
60	1,060	920	430	490	36.8	15.00	18.05	.92
	1,065	925	455	470	36.0	29.28	2.66	.99

[1] Unusual variation, probably due to skins holding and not permitting the establishment of equilibrium between fruit and sirup.

Average weight of fruit and sirup in canned plums.

Grade of fruit.	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Green gage:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	955	815	480	335	11.5	.....	.....	.....
Yellow egg: Water	990	850	540	308	9.6	3.50	2.61	1.22
Green gage: Seconds	965	825	475	350	15.0	.....	.....	.....
Yellow egg: Seconds	1,002	862	470	392	12.2	7.50	1.42	1.09
Green gage: Standard	1,014	874	509	365	18.7	.....	.....	.....
Yellow egg: Standard	1,023	883	516	367	16.8	9.25	3.09	1.21
Green gage: Extra standard	1,035	895	547	348	22.8	.....	.....	.....
Yellow egg: Extra standard	1,015	875	500	375	18.0	14.75	3.80	1.24
Green gage: Extra	1,065	925	495	430	21.6	.....	.....	.....
Yellow egg: Extra	1,050	910	480	430	25.0	16.25	4.59	1.21

The green gage and yellow egg plums behave so nearly alike that they may be considered together. Both leave large spaces in packing and, as a result of softening from processing, settle together. If the plums are slightly green, the cut-out will appear to be somewhat better than if fully ripe, but the loss in flavor more than counterbalances the gain in appearance. The effect of sirup on the fully ripened fruit is essentially the same from water to 30° sirup, the cut-out after draining being about two-thirds full; 40° sirup reduces it to not less than two-thirds, and 50° and 60° sirup about one-half. On fruit that is slightly immature the cut-out from water to 30° sirup is within three-fourths of an inch of the top; 40°, down about 1 inch; and 50° and 60°, about 1¼ inches. By weight, in 30° sirup, 400 grams give less than one-half a can; 450 grams, more than one-half; 500 grams, two-thirds; and 550 grams, three-fourths. The fruit tested was in prime condition for canning.

Raspberries (Rubus occidentalis and R. idaeus).

Raspberries are widely grown for consumption in the fresh state; very few are used for canning. They have distinctly more character than many fruits, and it would seem from the ease with which they may be grown that their use could be increased. They are grown and handled in the same manner as blackberries. The red and the black varieties are kept separate, as the red commands a higher price. The use of a sirup of the right degree is essential in bringing out the rich flavor. The process takes 12 minutes at 212° F.

Only a few experiments were made with raspberries, one part of the set being in No. 2 and one part in No. 2½ cans. The weight of fruit used in the No. 2 can was 380 grams and in the No. 2½ can 600 grams, so that the results on the cut-out are very nearly the same as if one size can had been used. The waste in canning is slightly greater than for blackberries.

Effect of varying degrees of sirup upon raspberries and the cut-out sirup (weight of fruit, 380 grams in No. 2 cans, 600 grams in No. 2½ cans; examined Oct. 10, 1912, Apr. 24, 1913, and Jan. 17, 1914).

Size of can and density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
No. 2 cans:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	695	595	350	245	7.5	4.75	0.00	0.63
	695	595	350	245	8.8	5.25	.00	.62
30	730	630	330	300	22.9	12.25	6.65	.67
	715	615	330	285	21.5	12.5	5.7	.60
50	735	635	310	325	29.5	12.00	13.77	.67
	730	630	315	315	29.2	12.75	12.11	.60
60	735	635	325	310	32.7	12.5	15.67	.66
	725	625	315	310	32.4	13.5	14.25	.55
No. 2½ cans:								
10	1,008	868	567	301	13.3	8.75	1.55	.75
	990	850	590	260	13.7	8.00	1.19	.76
20	1,015	875	590	285	13.2	9.88	.52	.70
	1,012	872	568	304	16.5	8.12	4.82	.79
	995	855	545	310	16.7	9.50	4.27	.77
40	1,005	865	560	305	17.2	12.74	1.12	.78
	1,042	902	515	387	24.3	9.00	12.23	.78
	1,030	890	532	358	23.5	11.75	7.84	.73
	1,035	895	565	330	25.2	19.52	2.79	.81

Raspberries should be given a slightly heavier fill, but the same sirup as blackberries, and should give almost the same result on the cut-out. The volume in the can appears somewhat less, as the berries mat together a little closer on draining.

Strawberries (Fragaria virginiana).

Strawberries used for canning are grown the same as for the market, but only varieties of uniform size and with a well-developed flavor are used. It is preferable that they be handled in shallow boxes and drawers; in no case should boxes larger than the quart size be used.

These berries are prepared by hand at the factory, as no machine has been invented which will sort them or remove the stems. If they arrive in the shallow boxes they are stemmed, and the soft or defective ones picked out. The good berries are placed in large shallow pans, care being taken to prevent the accumulation of a layer deep enough to squeeze out any juice, then washed in a single layer under sprays. While passing under the sprays they are gently rolled over, so that all parts will be struck by the water. They are filled into the cans level with the top and the cans weighed to insure against short weight. One of the best eastern packers has the following plan: The berries are stemmed and placed directly on enameled pie plates by one set of women. These are passed to other women, who weigh out a sufficient quantity to

just fill a can, after which the berries are washed under a spray of water and then poured into the can through a special funnel. The plates are rinsed before being returned for another lot of berries. The first impression is that the method is cumbersome, but in practice it is rapid and ideal for cleanliness. The same method is also used for other berries.

The strawberry needs a good sirup to develop its flavor fully and to hold it. After a sufficient quantity of sirup to fill the can has been added, it is exhausted for 3 minutes, sealed, and processed for from 10 to 12 minutes. The practice of kettle cooking is followed by a few careful packers. The berries and sugar are placed in a copper-jacketed kettle and heated slowly to the boiling point. A special dipper is used to lift out just enough solid fruit to each can, so that the sirup may be added afterwards to make the proper fill. The object is to give a can with more solid fruit. With some packers there is a loss of fruit juice, and this is used for flavoring sirups. There is a distinct difference here in the object sought, "the full can" being the aim of some, while others strive to get all the juice out as a primary product and can the remaining solids as whole fruit. The cans are sealed at once and processed for 6 minutes. The strawberry undergoes a marked change in weight and in volume, due to the action of heat and sirup.

Effect of varying degrees of sirup upon the strawberries and the cut-out sirup.[1]

Density of sirup (degrees).	Gross weight.	Weight of contents.	Weight of fruit.	Weight of sirup.	Brix reading.	Reducing sugar.	Sucrose.	Acidity.
Weight of fruit, 500 grams, No. 2½ cans; pack of 1913; examined Oct. 28, 1912, Apr. 23, 1914:	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Degrees.*	*Grams per 100 cc.*	*Grams per 100 cc.*	*Grams per 100 cc.*
Water	940	800	315	485	5.2	2.50	1.66	0.59
	915	775	340	435	5.4	3.25	.00	.57
10	940	800	310	490	9.6	7.50	4.05	.53
	940	800	310	490	9.4			
20	945	805	315	490	12.7	4.25	6.89	.59
	940	800	315	485	13.2	5.00	5.70	.60
30	960	820	325	495	18.0	4.25	11.87	.52
	985	845	360	485	19.4	11.50	6.18	.67
40	1,010	870	365	505	24.8	5.00	16.62	.64
	980	840	320	520	22.8	13.25	5.46	.50
50	1,015	875	355	520	29.4	5.50	19.47	.63
	1,025	885	360	525	29.0	12.50	10.45	.63
60	1,055	915	360	555	36.7	6.50	27.07	.54
	1,070	930	480	450	36.6	12.75	18.76	.59
Variety, Brandywine; weight of fruit, 500 grams; pack of 1913; examined June 2, 1913, July 2, 1913, Apr. 2, 1914:								
Water	910	770	320	450	6.6	4.75	.00	.52
	915	775	360	415	6.2	3.50	.00	.53
	910	770	420	350	6.5	3.86	.21	.51
10	940	800	300	500	10.3	8.00	.47	.63
	940	800	310	490	10.0	5.00	2.85	.58
	940	800	315	485	10.2	5.92	1.88	.49
20	955	815	330	485	13.9	5.00	5.94	.63
	955	815	320	495	14.7	5.50	5.94	.65
	960	820	335	485	13.9	8.94	2.64	.57
30	975	835	340	495	18.6	6.25	9.50	.55
	970	830	330	500	19.3	6.00	10.69	.53
	975	835	340	495	19.6	11.48	5.83	.53
40	985	845	345	500	23.6	6.50	13.78	.49
	990	850	340	510	24.6	8.50	13.54	.53
	980	840	360	480	24.3	22.12	.04	.55
50	1,015	875	360	515	28.7	5.50	18.05	.49
	1,000	860	365	495	27.8	12.00	11.88	.54
	1,005	865	350	515	29.3	27.20	.08	.53
60	1,025	885	335	550	37.0	5.00	25.65	.47
	1,020	880	360	520	34.7	10.00	19.95	.55
	1,010	870	375	495	34.2	26.94	5.42	.56

[1] A sufficient number of commercial samples was not received to make a fair comparative table.

The strawberry is subject to more shrinkage than any other fruit. Cans packed with 500 grams of prime fruit, using water, 10°, 20°, and 30° sirups, showed less than one-half the fill on the cut-out, and with 40°, 50°, and 60° sirups, the cans were just about one-third full.

Microorganisms.

Since a great deal of attention is given to the presence of microorganisms in food products as indicating spoilage, the following table is given to show the results of examination of canned fruits made during the season. The method followed was that of using the Thoma-Zeiss counting chamber, and only the sirup or fluid portion was examined. These results have a certain value for comparative purposes and are offered for that reason. The report is in two parts, one upon the products prepared in the laboratory and one upon samples submitted from different factories. The figures in both cases are low, somewhat lower than would be obtained upon the same samples if examined six or eight months after canning, owing to the closer adherence of the organisms to the fruit when first packed.

Number of bacteria, yeasts, and spores per cubic centimeter, and the percentage of 50 fields in which mold occurred.

Product.	Number of samples.	Bacteria per cc.	Yeasts and spores per cc.	Molds in 50 fields.
				Per cent.
Apricots:				
Laboratory samples	17	564,000	30,000	0.00
Commercial samples	37	830,000	220,000	.00
Blackberries:				
Laboratory samples	24	151,000	364,800	.33
Commercial samples	10	1,440,000	492,000	1.40
Cherries:				
Laboratory samples	61	468,000	109,000	.00
Commercial samples	40	960,000	165,000	.00
Grapes:				
Laboratory samples	21	442,000	139,000	.00
Commercial samples	13	1,015,000	474,000	.00
Loganberries:				
Laboratory samples	12	540,000	424,000	.00
Commercial samples	2	1,560,000	4,410,000	3.00
Currants, laboratory samples	9	399,840	279,960	.60
Peaches:				
Laboratory samples	17	670,200	56,400	.10
Commercial samples	96	984,000	189,960	.06
Pears:				
Laboratory samples	15	480,000	99,600	.00
Commercial samples	65	1,084,800	192,760	.03
Plums:				
Laboratory samples	39	276,000	67,680	.00
Commercial samples	26	544,560	150,000	.15
Raspberries, laboratory samples	17	280,000	194,000	.17
Strawberries, laboratory samples	31	387,120	106,440	.50
Tomatoes, laboratory samples	43	19,872,000	1,354,800	7.58
Apples, laboratory samples	5	159,840	9,996	.00

VEGETABLES.

The distinctive feature in the canning of vegetables is that they require heavier processing than fruits, and for sterilization need a higher temperature, or longer time, or both. Another feature is the substitution of mechanical methods for hand labor. Fruits require a large amount of hand labor in the preparation and in the filling of the cans, while with the majority of vegetables almost every step can be accomplished by a machine.

Asparagus (Asparagus officinalis).

The packing of asparagus had its beginning in this country at Hunter's Point, Long Island, now within the confines of greater New York City. The first packer was

William H. Hudson, who put up about 400 dozen tins in 1864. The package used was almost identical with the No. 3 square can of to-day. The preliminary treatment in the way of cutting and blanching was also very similar to that now used. The processing was different, for the cans were first held in a bath for 30 minutes, then vented, and afterward held for an hour and a half in a bath of boiling water. The industry grew fairly rapidly in New York and New Jersey, but has almost ceased since California became a producer in the early nineties. The real packing of asparagus in California was established by Mr. Hickmott, who began experiments in 1881 but was not very successful until 1890. The distinctive feature of his method was the erection of the cannery very near the asparagus beds, so that the product might be collected and delivered in a perfectly fresh state, as the holding of the product for even a short time greatly impairs the flavor.

The asparagus produced on the western coast has the advantage of unusual natural conditions for growth, as the beds are in the delta lands along the Sacramento and San Joaquin Rivers. The soil is of wonderful fertility, light and mellow, so that it may be hilled high to produce long, large stalks. The spring is cool, insuring growth that is not too rapid, each spear being succulent and tender. The stalks are naturally bleached so that they are very white. Even food officials have believed the canned article to be chemically treated to obtain the very pale color.

Asparagus is a costly product, because it can be grown only upon very valuable land and a great amount of hand labor is required. The growing is the same as for the market, only the beds cover hundreds of acres. The plants are set close together in rows 4 feet apart. Three years are required to bring them to a productive state. When the plants have stooled sufficiently to permit the removal of a part of the stalks for consumption, the rows are covered over with soil to a depth of a foot or more. These are kept hilled up in the spring and free from all weeds. This great depth forces the new stalk to grow about 1 foot to reach the light, and, as no color is formed until light reaches the tip, the stalk is perfectly pale or white. The harvesters pass between the rows looking for a spear wherever they see the ground cracked or broken. When found, a cutter very much like a carpenter's chisel is inserted at such an angle as to cut the stalk about 9 inches below the surface. The stalk is drawn from the ground carefully so that the top may not be marred nor snapped off. Only one stalk can be cut at a time and the cutting must be done every day or every other day. The cutters carry the stalks in baskets to convenient points and empty them between the rows. A man with a small sled follows closely behind the cutters, picks up the "grass," and cords it on the sled, keeping all tips in one direction. It is next hauled to some convenient point in the field where water is available. There the "grass" is picked off the sled and placed in a frame, the tips all turned in one direction against a smooth board wall. This frame is from 1 foot to 2 feet in height and from 6 to 8 feet long. When it is filled, a board is pressed on top of the grass, and by using this and the bottom as guides all stalks are cut to a uniform length of 7½ inches. All the stalk in excess of this length is waste. The next step is to dump the cut grass into a tank of water to wash off adherent grit. It is absolutely necessary that this washing should be done before any drying takes place, for with the drying a certain amount of staining develops, and this can not be removed by any subsequent treatment.

The stalks are picked out of the water by hand, again arranged with tips in one direction, and corded in crates in two rows, the tips being kept to the center. The boxes are hauled to the factory promptly, so that the asparagus can be used within a few hours, thus avoiding all possibility of wilting. At all the better canneries work upon the grass is begun within three hours from the time it is cut and stock is not carried over from one day to the next.

At the factory the first operation is to empty the crate upon a sorting table, where the stalks are sorted into five grades, based on size, and into two qualities, dependent upon whether the stalks are wholly blanched or partially green. They are further

sorted, separating the straight stems from the crooked. All the sorting is done by hand. The five grades for size, based upon the number of stalks which will go into a standard No. 2½ square can, are known as giant, mammoth, large, medium, and small. With giant stalks about 14 are required; mammoth, 20 to 22; large, 30 to 33; medium, 40; and small, 50. What are known as asparagus tips are put up in cans just one-half the regular size, about 30 per cent more stalks being required to fill the can. The so-called hotel tips are the cuttings made in trimming the asparagus to size and the whole stalks which are crooked or deformed. These are just as good as the other, though not so pleasing in appearance. Some of the large asparagus is peeled, or stripped, as the operation is more properly called.

After grading the stalks they are again cut to length for the different sizes of cans used; 5½ inches for the regular square can; 4 inches for the No. 1 tall and No. 2; and 3 inches for tips. The loss of weight in preparation for tall cans after the asparagus reaches the factory is about 16⅔ per cent for No. 1 tall; for No. 2, about 40 per cent; and for tips, 60 per cent. The part cut off represents waste at the present time, as only a very small part of this is used as soup stock. After grading and cutting the stalks to length, they are blanched until they are just softened through, so that they are flexible but will not snap off on bending. The time required is from 30 seconds to 3 or 4 inches, depending upon the size and age of the material. Then follows heavy spraying in cold water, and again each spear must be hand-sorted for color, the pure white and that tipped with green. They are then filled into cans, always keeping the tips up. The can must be crowded, for there will be some shrinkage after processing; if the can is not well filled it will not ship well, and the ends and side buds will be knocked off, giving an unattractive appearance. The interspaces are filled with brine testing about 8° Balling (about 6½ ounces of salt per gallon of water). The process takes from 12 to 22 minutes at 240° F., and the cans are cooled at once.

The asparagus tip was first packed to use the stalks which might be cut somewhat short or be broken, then to care for the tender ends which might be left when the grass was delayed in transit to the cannery or forced to stand overnight. Now they are packed as a regular product, as they are held in high esteem by the consumers. It requires nearly 20 per cent more tips to make a can than when the whole stalk is used, which necessitates a higher proportionate cost. The enormous loss in trimming the stalks to the required length and the hand labor involved in every operation make the cost of asparagus necessarily high, and, while a large part of the work might be simplified, cost can not be materially reduced.

Some experiments were conducted in canning asparagus to note the effect of standing. One lot was packed within 3 hours after cutting, a second lot within 24 hours, a third within 48 hours, a fourth within 72 hours, and a fifth within 96 hours. Each lot consisted of two parts of about 20 cans each, one part being filled with long or full-length stalks, and the other with tips.

The lot put up immediately on arriving at the factory was perfectly tender from the tip to the base in every stalk. It had a bright, clean, crisp appearance.

The lot put up within 24 hours lacked some of the clean luster characteristic of the fresh, the tips were all tender and gave no evidence of unnatural flavor. The full-length spears were excellent at the tip, but more than 30 per cent were a little fibrous at the butt and had the beginning of a bitter flavor.

The lot held for 48 hours showed more dulling in color, the beginning of a yellow cast, and a little wrinkling of the stalks as though they were shrinking. The tips were good, with only the beginning of toughening at the base and some bitter taste. In the full stalks the base was decidedly fibrous for nearly one-half its length and had a decidedly bitter taste at the butt, becoming less marked as one approached the tip. About one-half the stalk was edible.

The lot held for 72 hours showed similar changes in a still more marked degree, more yellowing, more furrowing or wrinkling of the stalks, decidedly more fibrous

material, and the development of a strong bitter flavor, more marked at the base and extending within about 1½ inches of the tips. The full-length stalks were not edible, but the tips might pass for a low grade.

The lot held for 96 hours had a poor, sickly yellowish-green cast, and was decidedly wrinkled and very tough and bitter throughout its entire length. It was not edible, the bitter principle being strongly developed. This asparagus was kept in a moderately cool place, but had no water turned on to keep it moist. It was not subjected to unusual drying. The loss in weight per hundred the first day was about 4 pounds, and the most of this was probably from water which had been held between the stalks after the field washing. On the succeeding days the loss was only from 1 to 2 pounds per hundred. The shrunken appearance after 72 hours gave the impression of a much greater loss in weight.

Experiments were also made with the use of lacquered cans, and while the results were interesting they have not shown an improvement from any standpoint. The most important advance made during the year has been the perfection of the square open-topped can. The round can is objectionable because it permits the contents to roll when being handled or in transit and breaks off the top and side buds, injuring the appearance of the stalk and liquor.

Beans, Green (Phaseolus nanus).

String beans form a regular side dish at almost every hotel, and they are generally the canned article. There is a large pack of beans each year, and while hotels and restaurants were formerly the principal buyers a large demand for home use has been created in the past few years. The beans raised for canning are produced in the same way as for the market. The growth is best when the season is fairly moist and cool, the majority of the beans being produced in northern New York and Michigan. More recently large packs have been put up in Wisconsin.

The beans are picked by hand. They are gathered as young as possible. The best are about 2½ inches long and less than a fourth of an inch in thickness; the large beans become tough and stringy. At the factory the beans are graded in five sizes by means of special machinery, the essential feature of which is a series of vibrating screens made of rods or bars running in one direction. These rods are generally set 18, 14, 11, and 8 sixty-fourths of an inch apart. The beans are fed in over the coarser screen first and those which fail to pass through constitute one grade. As the beans pass to each succeeding screen the next size is separated, and the smallest pass through last. The work is done better than it was formerly done by hand.

The next step is to snip or string the beans. Some varieties of beans are so nearly stringless that the simple snipping of the ends is sufficient, but when they become old, hand stringing is necessary. The cutting of the ends, or snipping as it is called, can be done well by machinery. It is also the practice to cut the large beans in lengths of about 1 inch. All beans are well washed, placed in wire baskets, and blanched, or they may be blanched in the cylinders used for peas. The time required for blanching will vary with the age; the small-size young beans will require only about 1½ minutes, the larger ones if tender will require about 4 minutes, and if hard and tough they may require 8 or 9 minutes. It is the rule of good processors to blanch until the beans are tender, irrespective of time, and for that reason many prefer the basket in a tank of boiling water to the pea blancher.

The blanched beans are filled into the can by means of a special bean filler. This machine carries a tray, holding 4 dozen cans, and has a hopper above it with holes corresponding to each can. The beans are poured into the hopper, the quick vibrating motion of which shakes the beans into the can. As a further precaution against short weight, each can is weighed and any deficiency in fill is made up by hand. A weak hot salt brine is used to fill the interspaces in the cans, which are exhausted, capped, and processed for 30 minutes at 240° F., as for peas. A full can should weigh not less than 13 ounces, exclusive of the liquor.

Beans, Lima (Phaseolus lunatus).

Lima beans are grown for canning both as a green bean and as the bean in succotash. There are two varieties, the pale or true Lima and the bush variety. The former is but little grown for canning, as it must be gathered by hand the same as string beans, while in the case of the bush beans the whole vine is taken up and hauled to the factory, as in the case of pea vines, and then run through a pea viner to shell the beans. The speed of the viner is changed to meet the altered conditions. The beans are graded generally into four sizes, if canned, but are left ungraded if intended for succotash. It is also becoming the custom, as with peas, to can some beans ungraded. A better flavor seems to result from the combination than is obtained when they are canned separately. The sizes are as follows, and are obtained by sifting over the screens with openings 24, 30, 31, and 32 thirty-seconds of an inch. Those passing through the first screen are called tiny; through the second screen, fancy; through the third screen, medium; through the fourth, standard. Those passing over the last screen are sometimes designated large or mammoth beans. The beans are blanched as peas are, and the can is filled so that after processing it will be full and just covered with brine. The process is the same as for peas. A full can should weigh not less than 13 ounces, exclusive of the liquor.

Beans, Wax.

Wax beans are handled in the same way as string beans. More attention, however, is paid to sorting, as any spot will show on the light surface. The weight of the beans in the can should not be less than 10 ounces, exclusive of the liquor.

Beets (Beta vulgaris).

Beets grown for canning must be of a deep-red variety, evenly colored throughout. Pale or uneven-colored beets present a very poor appearance in the can. The beets used for canning are mostly grown in New York, and are cultivated as in the garden, but in large acreage. The tops are cut off and they are hauled to the factory as tomatoes are. The time of packing is in the fall, usually the latter part of September.

At the factory the beets are graded into four sizes—small, sometimes called rosebud, the beet being less than 1 inch in diameter; medium, the beets being from 1 to 1½ inches in diameter; large, those from 1½ to 2 inches; and very large, those over 2 inches. The very large beets must be cut into pieces for canning, and for that reason are called cut beets. The grading is done in a wooden squirrel cage having the slats set at proper distances or over tables having holes of the size indicated.

After being graded the beets are soaked in tanks of water to soften the adherent dirt and are then sprayed well. The beets are next placed in large iron crates or heavy iron baskets, placed in the retort, and steamed for 20 minutes at 220° F. This loosens the skin so that they may be peeled with the best possible results. The peeling is done by hand, as is also the filling of the cans. Only water is used on the beets, though salt may be added at the rate of a teaspoonful to the can; enamel cans should be used, otherwise the beets will be discolored. The process on beets is 245° F. for 1 hour.

Corn, Sweet (Zea mays).

Canned corn is the result of the persistence of Isaac Winslow, of Maine. He was a sailor by occupation. In his wanderings upon the high seas he visited France and learned the method of preserving food by canning. The advantage of such foods, particularly to sailors, was obvious. Mr. Winslow began experimenting on the canning of corn in 1839, the first trials consisting in boiling the corn on the kitchen stove for varying periods of time. The cans were marked and a record kept of each lot. The results were mostly failures, but a sufficient number of cans were saved, and these were of such good quality that the efforts were continued. The succeeding years gave

essentially the same result. In 1843 he built a small boiler to generate steam and a wooden box in which to put the cans, so that the cooking might be done in a closed steam chamber. As the results were less successful than in the previous years, the steam box was discarded. It was not until 1853 that he had sufficient success to warrant applying for a patent on his method, and it was regarded with so much distrust that the letters were not granted until 1862. Winslow first packed the corn on the cob, but this was bulky, and he believed that the cob absorbed some of the sweetness. He next pulled the kernels off the cob with a fork, and finally cut the corn with a case knife. Winslow's apparatus and methods were crude, but he discovered the principles which underlie the canning of corn. It may also be said that he and his successors brought fame to Maine corn as a canned product, and this reputation persists to the present time.

The canning of corn is a large industry in Maine and other States extending from New York to Maryland, west to Iowa, and north to Minnesota. In most of the Eastern States the crop is grown by numerous farmers in small patches of a few acres, while several of the western factories raise their own corn, covering hundreds of acres. At Hoopeston, Ill., two canneries use the product of 7,500 acres. Claims are made that certain sections produce better and sweeter corn than others. This is not always sustained by facts, for quality is also affected by the variety and state of maturity when gathered. Again, some canners pay more attention to the quantity of corn grown on an acre than to the quality. The seed used is grown by specialists, as a rule, and a very large part of it comes from Connecticut, a State in which no canning of corn is done. The type of corn used now is quite different from that canned several years ago. The effort is to develop a tender, fine-flavored sweet corn. The ears are of two types, those having large, flat kernels arranged in rows and those with small, long kernels irregularly placed. Stowell's Evergreen is typical of the former type and Country Gentleman of the latter. The corn is planted and cultivated in the same way as field corn, and is gathered by snapping off the ear when it is in its prime. The ears are hauled to the factory in the husk in order to protect the kernels from injury in handling and from dirt and exposure.

A modern corn-canning plant is a large establishment, equipped with valuable automatic machinery to do the work in a rapid, cleanly manner. When the corn arrives at the factory it is dumped from the wagon onto a conveyer, which carries the ears to different parts of the husking shed as they are needed. Most of the husking is done by hand, but this practice will undoubtedly give way to machine methods, as the husking machines have been almost perfected in recent years. As rapidly as a bushel measure is husked it is put upon a conveyer, and while on the way to the silking machine is sorted for quality. A high grade may be secured only by selecting ears with grains which are uniformly tender. Corn which is too old or too young to make a fancy grade of goods is taken out and held until a sufficient quantity accumulates to make a run on a lower grade. The silking is done by means of rolls and brushes. As the ear revolves on its axis and at the same time is carried forward, it is gently wiped by rapidly revolving brushes, which pick up any silk that may be attached. This work is done with remarkable rapidity and by machinery so carefully adjusted for any irregularity in the size of the ears or even in a single ear that there is no chafing or bruising of the tenderest grains. This process is immediately followed at some factories by a thorough spraying with water, while at others this is omitted, the claim being made that a certain flavor is lost.

The corn is cut by machinery, and from the time the ear is fed into the cutter until the corn is sealed in the can it is not again touched by hand. The ear is forced through a series of curved knives, mounted in an adjustable circular frame, so that they will accommodate themselves to the varying size of the cob. Scrapers complete the work by removing the grain and soft bits of kernel at the base. The corn again passes through a machine to remove bits of silk, husk, or cob, so that the final product is as

clean as machinery can make it. This cleaner consists of a series of wire combs, which intermesh as the corn passes through, and wire cylinders which act as sifters.

The corn is next mixed and cooked, and in this operation it is necessary to add some water, otherwise it would become a dry, tough mass in the can. The quantity of water used will depend upon the consistency desired and the condition of the corn. Some varieties require more than others, but the average quantity used in cream corn is about 5 ounces per can. It is also usual to add both salt and sugar to the corn to give the desired flavor. This is used in all grades, though more carefully in the high grades than in the low. The eastern packers, as a rule, use more sugar than the western.

The care with which the cooking is done before the corn enters the can determines in a large measure its appearance. Too much brine will give a sloppy can, while too little gives a dry can. Insufficient cooking will leave the brine and corn separated; the quantity of brine may be right but the corn may be dry in the bottom of the can and most of the brine on top, or they may be mixed but not blended. The preliminary heating is done by steam, using automatic machinery, which heats and evenly mixes the corn and brine and at the same time fills the cans. The corn enters the cans at about 180° F., and the capping is done in the usual manner.

Corn is one of the most difficult products to process. It requires a temperature of about 250° F. for 75 minutes to insure sterilization. There are packers who process at from 240° to 245° for 90 minutes, and others who process their corn twice to insure keeping. The higher the temperature the browner the corn and the more pronounced the cooked taste. The consistency of the corn makes a great difference in the heat which must be used; the drier the corn the slower the heat penetration.

Corn is packed as "cream corn," or, as it is sometimes called, "Maine style," the kernels being cut as already described and the portion scraped from the cob added. The product should be of a thick, creamy consistency. Again, the corn is cut from the cob as closely as possible by knives, but only the whole grains are used, the bits and scrapings being discarded; corn used in this way must have long, slender grains, commonly called "shoe peg," and the quantity of brine so secure as to keep the kernels separate. This method of preparation is called "moist condition style" by the trade. In some instances the corn is run through a recutterding for gives a grainy effect or one like the cream corn, depending upon the method of handling. This procedure is also followed in working up corn which has become too old to make a good regular pack. Corn may be run through slitting machines, which cut the grains open on the end and then squeeze out the contents, leaving it free from hull. Cut corn is also run through a "cyclone," a machine for forcing the creamy portion of the kernel through a fine sieve, thus removing all of the hull and giving much the appearance of green corn meal.

Field corn is not used in canning. Some of the sweet corn used produces very large ears and coarse grains, which give rise to the suspicion that field corn has been substituted. There has been a very general improvement in sweet corn in the last 10 years, and it will probably not be long before this coarser variety will give way to a better and sweeter one.

A can of fancy corn when opened should be well filled (within three-eighths of an inch of the top), should be absolutely young and tender stock, medium moist, practically free from silk or bits of cob or husk, only slightly darker than natural or of a light golden-brown color, and have the distinctive young corn flavor. The weight of the contents should be about 21 ounces. If put up in "Maryland style," the kernels should be separate and the brine nearly clear and the corn should weigh not less than 13.5 ounces, exclusive of the liquor.

A can of standard corn should be well filled, reasonably tender, fairly bright color or slightly brown, and nearly free from silk, bits of cob, or husk. The flavor should be characteristic of young sweet corn. If put up in "Maryland style," a part of the kernels may be somewhat hardened and the brine a little cloudy.

Peas (Pisum sativum).

The transition from the custom of growing a small patch of peas in the garden to supply a few meals of a choice vegetable during the growing season to that of growing hundreds of acres to supply a canning factory packing an article available at all seasons is but an incident in the development of a great industry. The garden bed was spaded, raked, and planted by hand. Brush was obtained from the orchard or wood lot, and the rows "stuck" in order to insure the vines proper support. When the green peas were picked and carefully prepared, they made what was at one time styled a dainty dish. The fields are now cultivated, sowed, and the crop harvested by machinery the same as any farm crop. There are several factories which take the entire yield from more than 1,000 acres. The plants selected have sufficient rigidity, no added support being necessary. The whole plant is hauled to the factory while fresh and green, the same as a load of hay.

The canning of peas dates back to the beginning of canning. Peas are one of the three large crops packed. In this country the packing of peas is confined largely to those States having a cool spring and plentiful rainfall. The southern limit of successful growing seems to be from Maryland west to Indiana and northwest to Minnesota. Some peas are also grown on the highlands in Colorado and a few on the western coast. Wisconsin, Michigan, New York, and Indiana lead in this crop.

The pea used for canning belongs to the garden variety, *Pisum sativum*, of which there are two general classes, the early, or round smooth pea, and the wrinkled pea. The latter is much the sweeter. The Little Gem and Alaska are typical of the first class, and Horseford's Market Garden, Admiral, and Advancers of the second.

The peas are generally sown upon good ground, well prepared, as early in the spring as frost will permit, and no subsequent cultivation given (except in California). Instead of all being sown at one time, the seeding is made to extend over several weeks, in order to prevent too many maturing at one time. When the peas are well grown and are still very tender, they are cut by mowing machines or special pea harvesters, and are then [illegible]ed upon wagons and hauled to the factory. Until a few years ago, the pod[illegible]canning plant [illegible]m the vines in the field and taken to the factory in baskets or bags. [illegible]y to do th[illegible]ated a very large force of men, women, and children in harvesting, and adde[illegible]n to the cost of the product. There are only a few factories in the United States which follow this method at the present time, and it is limited to a part of the pack.

The vining machine, which is used for separating the peas from the pods while they are still on the vine, is a very simple and ingenious device to accomplish a difficult task—the shelling of the tender pea so carefully that it will not be injured. It consists of a large cylinder, perforated with many holes, which are large enough to permit the peas to pass through, but not the vine. Within the cylinder is a heavy shaft, bearing strong paddles or beaters. The cylinder is made to revolve rather slowly and the beaters very rapidly, in the opposite direction. The vines are fed in at one end of the cylinder, are carried upward by its motion, and fall upon the beaters, which strike the pods, causing them to burst open and discharge the peas. The peas roll out through the holes in the cylinder, and the vines pass out the opposite end. The present vining machine is a modification of the podding machine which was invented by Madam Faure. It was the first important step in the development of the pea-canning industry.

The next step in the process is that of cleaning, which consists of two operations; first, passing the peas through a fanning mill to remove pieces of pods, leaves, and dirt, and, second, washing, which is done in wire cylinders known as squirrel cages. These cylinders are set on a slight incline and made to revolve slowly, so that peas which enter at one end gradually roll out at the opposite end, and while doing so they are well sprayed with pure cold water. After the washing, the peas are graded for size. This is done by passing them over vibrating screens, which have holes of a

definite size, or through cylinders, with sections having perforations corresponding to those in the screens. The perforations are standard and give the following sizes in the peas: Petits pois, extra sifted, sifted, early June, marrowfat, and, in the case of late peas, the telephone. If the peas are properly labeled, they should be uniform in size. Some manufacturers, instead of turning out all these sizes, combine two sizes in one. A few peas are sold ungraded or with only the first and second size taken out. The petits pois should pass through an 18 sixty-fourths inch hole; the extra sifted, or extra fine, through a 20 sixty-fourths inch hole; the sifted, or fine, through a 22 sixty-fourths inch hole; early June, through a 24 sixty-fourths inch hole; while the marrowfats pass over the ends of the screens. With sweet wrinkled peas, a 26 sixty-fourths inch screen is used to separate the marrowfats, and those remaining above pass over as telephone size. These designations, which were partially adopted from the French, have been in use for a long time, and refer to size and not to variety nor to time of gathering, as would be inferred from the name "early June." The term "early June" has, in recent years, come to have another meaning, that of including all of the smooth or Alaska group of peas in distinction from the sweet wrinkled varieties. We therefore find smallest-sifted early June, extra-sifted early June, and sifted early June, as distinguished from the same names applied to sweets. The trade terms have little meaning to the consumer and could be supplanted by proper descriptive terms to the advantage of all concerned.

Peas are also graded for quality. Those that are small, young, and tender, so that they will crush easily between the thumb and finger, are considered to be the highest grade, while those that have a considerable percentage hard, turn brown upon processing, or cause clouded liquor in the can are of a lower grade. The grading is done largely upon the judgment of the inspector as the peas arrive, and later by the superintendent.

The peas may be mechanically graded for quality before, but preferably after, grading for size. This is possible because the old or hard peas are heavier than the younger and more tender ones. As peas will not all mature alike on the same vine, nor in the same field, it is not possible to cut them so as to secure absolute uniformity. The more slowly the peas mature, under fairly cool moist conditions, the tenderer they will be, so that in some sections the necessity for grading for quality is less than in others. This grading is effected by means of brine, which is made to a strength that will float those that are tender, the harder ones sinking. The first quality can be skimmed off, and those that sink can be again separated in another and heavier solution, giving a second and third grade. The first grade will be lighter in color and softer on pressure, and will give a clear liquor on canning; the second grade will be slightly darker, and the liquor cloudy; while in the third grade the size will be uneven, the peas dark and hard, and the liquor very cloudy and thick. In dry seasons the grading will not be so good, as there is less difference in the weight of the peas. It is possible to get 15 grades of peas, depending upon size and quality, from the same load, the difference being sufficient to be easily distinguishable in the finished product.

When the peas leave the graders they pass over slowly moving belts in a single layer, and those which are split, off color, or defective are picked out. This is the only operation in which it is necessary to touch the peas with the hands.

The peas are blanched, or more properly parboiled. They are boiled just long enough to soften them uniformly and to remove the mucous substance on the outside. The time for the blanching will vary from one-half minute for the very tender small peas to 15 minutes for the overmatured large ones, some variation being necessary for each size and degree of hardness. Most of the blanching requires from 1 to 4 minutes.

The matter of blanching is exceedingly important, for upon it depends in a large degree the appearance of the peas and the character of the liquor. There are several different styles of apparatus in use for blanching, the simplest being a large trough containing scalding water in which wire baskets holding the peas are placed for the re-

quired time. Another device consists of a cylinder which is made to revolve in a tank of water and gradually cause the peas to pass through in a continuous stream by means of a large screwlike conveyer. The latest type is a tank having three compartments; the peas are fed in at one end and the hot water at the other, so that the water in which the peas are first scalded is being constantly renewed from the next tank, and, as the peas emerge, they come from the freshest, cleanest bath. The peas are again washed after blanching and before going to the filling machines.

The pea fillers should measure out a given quantity of peas and deliver them into the can with the minimum of cutting or bruising. The greater the number of injured peas the less attractive the contents, both because of splits and because of cloudy liquor. The fillers should be adjustable, that the cans may receive a fill according to size and age. The younger and smaller the peas the greater the fill, and vice versa. Old peas absorb liquor in the process, while the succulent ones take up very little. The liquor used in canning peas is made up of water, salt, and sugar, the proportions being a matter of taste. The eastern packers, as a rule, use more seasoning than the western. The liquor is added after the peas have been put in the can. The subsequent capping and processing is the same as for corn. The process is from 235° to 240° F. for from 35 to 40 minutes, depending upon the freshness and state of maturity. The cans of peas should be immersed in a cold bath at once after the process is finished, in order to arrest cooking and insure a clear liquor.

The canning of peas requires special care. If a fine product is to be secured, there must be careful selection in the field and continuous and rapid work from start to finish after the vines are cut. "Only an hour from the field to the can" is not literally true, but it is approximately so. The work is almost wholly done by automatic machinery connected by special conveyers in such manner as to insure continuous action. At all the various steps the washing is of the most thorough character, and in some of the best factories almost a gallon of water is used in the preparation of each can. American peas of the highest grade represent the best that is accomplished in the canning industry, and are unexcelled by any foreign production.

The cost of a can of peas will vary with the size and quality. The very tender smallest sifting peas, or "petits pois," are the most expensive for the reason that but comparatively few are produced; not more than 5 per cent of a good crop will be of that grade. The price gradually decreases through the sizes to the marrowfat, which is the cheapest. There is more nutrition in the larger sizes, and, if properly graded, they have the better flavor. Ungraded peas have a particularly good flavor, though they are not so attractive because of lack of uniformity.

A well-filled No. 2 can of peas should have a net weight of about 21 ounces, of which slightly more than 13 ounces should be peas and 7 ounces liquor.

First-grade peas should be from selected field stock, or the lightest weight if separated, and the can should be well filled with peas that are uniform and true to the size indicated, even in color, absolutely tender, of good flavor, and covered with a clear liquor. The weight of the peas, exclusive of the liquor, should be not less than 12 ounces.

A can of standard peas should be well filled with good field-run stock, the peas fairly uniform, of the size indicated, and covered with liquor, which may be more or less cloudy but not thick. There may be some variation in color, but the peas should be tender, or only a small proportion hard, and of good flavor.

Pumpkin (Cucurbita pepo L.).

It used to be the custom to associate pumpkin pie with the Thanksgiving season, but the tin can has lengthened its season to the full year, and made it especially convenient for the home piemaker.

The pumpkins used for canning should be of a hard, sweet variety, and evenly ripened. The meat should be of good texture, golden yellow, but not watery. It has

been the custom generally to grow the pumpkins with the corn, but a few canners find that a more satisfactory yield and a far more uniform quality are obtained by growing in the open field as a special crop.

The pumpkins are carefully selected, stemmed, and well washed to remove any adherent dirt. They are cut into large pieces, either by knives or roller disks, and are subjected to a general washing in a heavy squirrel cage, the principal object being to remove the seeds and loose fiber. The pumpkins are then put into large iron crates and cooked in the retort until soft, which requires about 20 minutes at 240° F.; they are next run through a cyclone, which removes the hard part of the skin and the tough fiber. The pulp proper is cooked very little if it is of a good consistency, but if light or thin it is evaporated until it is of the right body. It is filled into cans while hot, sealed at once, and processed at 250° F. for 90 minutes.

Some packers cut the pumpkins in halves and peel and core with special revolving knives. This necessitates considerable extra hand work, but is particularly advantageous when the pumpkins do not ripen uniformly. It does not have any apparent advantage over the direct-heating method if the raw material is of uniformly good quality.

Pumpkin is packed almost exclusively in No. 3 cans, which should be enamel lined, so as to prevent action on the tin, and also to aid in the retention of good color and flavor.

A good can of pumpkin when opened should be filled within one-half inch of the top; should be fairly heavy, smooth, evenly screened, free from fiber, and uniformly colored. A can lacking an inch or more of being full, containing coarse, fibrous, or thin and watery tissue, is not a first-class article and is short weight. A No. 3 can should contain at least 33.5 ounces.

Squash (*Cucurbita ovifera*) is grown and handled in the same way as pumpkin.

Rhubarb (Rheum rhaponticum).

Rhubarb is grown in fields, in rows 4 feet apart and hills about 2 feet apart in the rows, and cultivation is the same as for potatoes. The soil must be rich to give a luxuriant growth. The rhubarb is harvested when the leaf stems are of large size, which may be at any time from the middle of May until the middle of August.

In harvesting the best stalks are selected, the small or undesirable ones being left to take care of the plant. The pulled stalks are made into bundles; the leaf and butt are then cut off and the stems placed in crates to be hauled to the factory. The hauling is done in the same way as in the case of tomatoes.

At the factory the rhubarb is washed in large tanks of running water and at the same time inspected for any imperfections. The next step is the cutting, which is accomplished by means of a series of small saws set 1 inch apart on a shaft. The rhubarb is laid on a carrier, which feeds each stalk crosswise to the saw. The pieces ready for the can are therefore 1 inch in length and the size of the stem. The cans are filled by means of a string-bean filler, and as much is put in as can be shaken below the level of the rim. Hot water is added to fill the interspaces.

The practice in some factories differs in some particulars from that given here. First, in that the stems are stripped or peeled before being cut, and second, in that the rhubarb is heated in a preserve kettle before filling into the can. In the latter case only a very small quantity of water is used, as in the cooking sufficient juice is extracted to furnish part of the liquor in packing. This style of pack is put up in No. 3 and No. 10 cans. The former is put up only in No. 10 cans for pie purposes. The process is 13 minutes at boiling temperature. The difference in the quantity of rhubarb which will go in a No. 2 can in the raw state and blanched is as 250 grams to 400 grams. The action of rhubarb on tin and enamel is very severe, so that this product can not be made to keep indefinitely in such cans.

Succotash.

Succotash is a mixture of green corn and green beans, the Lima bean being the one generally used. Succotash has also been made from green corn and soaked beans, as in most places the corn and beans will not come to maturity at the same time. The flavor of succotash made from good corn and strictly green beans is better or more delicate than that made with dried beans; otherwise the latter is in no way inferior to that made from the green bean; but when the dried bean is used the fact should be indicated on the label. In the regular field run of Lima beans some will be further advanced than others; while the pods may all be green, in blanching some of the beans may turn white and on breaking they may appear mealy, and thus give the appearance of being soaked when the can is opened. In fancy succotash these white beans are picked out by hand. A succotash should consist of not less than 20 per cent of beans, and in the high grades there is more nearly 40 per cent beans, either graded or ungraded for size. The cut corn and blanched beans are mixed, after which they are treated in the same way as corn, being given the same sugar and salt brine, preliminary cooking, and process. The net weight in a No. 2 can should be not less than 20 ounces.

Spinach (Spinacia oleracea).

Spinach, which is of rather recent origin as an article of canned food, is growing rapidly in favor. The plant is grown in drill rows or sown broadcast in fields. It is harvested by cutting the entire plant close to the ground when the leaves are crisp and tender, at which time it is about 10 inches high. There is a spring crop and a fall crop, the quality being better when grown in the cool part of the season.

The leaves are stripped apart by hand, the discolored, tough, and coarse portions being removed. The next step is the washing, which must be most thorough, as the presence of any sand or grit will be detected when the spinach is eaten. The washing can be done best in a revolving cylinder after the style of a squirrel cage or blancher in which there is a perforated pipe delivering sharp sprays of water. The spinach should be fed in thin layers to insure the washing of all leaves. A test for thorough washing is to empty a can into a white dish and carefully separate the leaves, when the sand will collect at the bottom. The spinach is blanched from 3 to 5 minutes, after which it is filled into the cans by weight. During the filling it is again inspected for discolored material.

Experiments made consisted in filling No. 2½ cans with 475, 560, 640, and 700 grams (17, 20, 23, and 25 ounces). The 475 grams made the can only about two-thirds full, and on the cut-out gave 415 grams of solids and 360 grams of liquid. It was manifestly slack filled. The cans receiving 560 grams lacked 1 inch of being full, while on the cut-out the solids weighed 515 grams and the liquid 245 grams. The can had the appearance of being loosely packed. The cans receiving 640 grams were nearly level full; on the cut-out the solids weighed 580 grams and the liquid 225 grams. The appearance was that of being slightly too full, as the liquid did not quite cover and there was some browning on the outside. The cans receiving 700 grams were hard-packed; on the cut-out they gave 630 grams of solids and 170 of liquid. The can was overfilled, the product was browned on the outside, and about 25 per cent of this fill were not sterile, as the mass was so dense that the heat failed to penetrate to the center. These experiments would indicate that the proper fill is about 600 grams.

The cans are thoroughly exhausted and then processed for from 35 to 40 minutes at 235° F.

Sweet Potato (Ipomoea batatas).

Canning sweet potatoes is of rather recent origin, but the rapid growth of the business shows how readily a cheap food will be taken because of the cleanly manner in which it reaches the consumer and the elimination of waste in handling. The sweet potato

can not be kept in the open without shrinkage and can not be marketed like white potatoes; therefore canning is used to extend the season throughout the year. There are two varieties canned, the yellow or Jersey type, grown extensively in New Jersey, Delaware, Maryland, and Virginia, and the whiter or southern type, grown in the South. The former is preferred in most markets, owing, in part, to the better appearance, the color being a clean yellow. The southern type is sweeter but inclined to turn a rather dark, dead color and to become slightly watery.

When the potatoes are received at the factory they are graded roughly for size, those more than 1¼ inches in diameter being placed in separate boxes so that they may be given a heavier cooking without overcooking the smaller ones. They are next washed, after which they are placed in crates, the layers not being more than 6 inches deep. The crates are then run into retorts and the potatoes given a steaming at 240° F. for from 9 to 12 minutes, depending upon their size and the length of time they have been out off the ground. The object is twofold, to heat the skins so that they will come off easily and to partially cook the potato before it enters the can. A quick, high heat applied for a short time will loosen the skin much better than a low temperature applied for a longer time. The peeling is done as soon as possible after the potatoes are taken out of the retorts, and, if the work has been well done, the peel is slipped off by squeezing between the fingers and not by cutting or scraping. The fresher the potatoes are from the ground the less steaming will be required, and also the less waste. Potatoes held for several weeks or allowed to dry in the air will show double the waste of those freshly dug. Peeling is also done by the lye process, such as is used for peaches, and is successful on the freshly dug product. In addition to the spraying they are vigorously brushed by revolving brushes, but there is always need for some hand trimming. The skin is also removed by means of the abrading machines used for white potatoes; these potatoes need hand trimming, as the machine does not rub in the creases and depressions. After preparation by lye or machine the potatoes are given a preliminary cooking to soften them before being packed in the can.

The potatoes are rushed from the peelers to the filling tables so that they may be placed in the cans while still warm. Little attention is paid in filling to layering the potatoes in the cans, the object being to fill closely and then heap on a sufficient amount so that, when pressed down, the interstices will be filled. They are packed either wet or dry, the latter method being preferred. Some packers in putting up a "solid pack" add about an ounce of water to the can so that sufficient steam will be generated to prevent oxidation or darkening. The addition of any water is unnecessary, and, as soon as packers learn how to handle this product, it is probable that the practice will cease. The filling should be strictly by weight, as that is the only method of securing a uniform fill.

As soon as possible after filling, the potatoes should be given a thorough exhaust. The usual steaming for 3 minutes is insufficient, as the outside only is heated and the inside may be nearly cold. Cans examined in coming from the exhausts may show a temperature of 135° F. on the outside and top and only 70° or 80° in the center. As the heat penetrates the potato very slowly, a second heating in the retort or from 12 to 18 minutes in the exhaust box is not unreasonable. If well heated the cans are not likely to be overfilled, as the expansion will be such as to cause a part to be thrown out before capping. If the right quantity has been weighed into the can and the lid lightly crimped on before exhausting, the contents will expand to fill all interstices. The packers know that the can must be well filled to preserve the clear bright yellow color, but if the exhausting is imperfect springers or flippers are almost certain to result. The bane of a slack-filled can is darkening of color and of the overfilled can is the springer, the correction of both being proper weight and exhaust. The sealing is done in the usual way, the general practice being to process for 3 hours at boiling heat for No. 3 cans. Sterilization may also be secured by processing at 240° F. for 70 min-

utes. Some experiments were made on using temperatures above boiling for a shorter period, but as the temperature rises above 220° F. the color becomes darker.

The canning of sweet potatoes is still in an experimental state, as brokers and jobbers have demanded an appearance which has been attained for the most part by overfilling and which is prone to produce springers. These are sound and wholesome as food, but the can presents an appearance which makes it unmerchantable and, unlike products containing liquid, a part can not be withdrawn and the can resealed.

Tomatoes (Lycopersicon esculentum).

The time is easily within the memory of many persons when tomatoes were thought to be poisonous. A few persons in the Eastern States used them 70 years ago, but they did not become common until a much later period. In the West the prejudice against them persisted until less than 40 years ago. The first record of canning tomatoes is that of the work done by Harrison W. Christy in 1847 at Jamesburg, N. J. Tomatoes are now used in enormous quantities in the fresh state and head the list of all vegetables as a canned product. Thousands of bushels are also used in the manufacture of ketchups, chili sauce, and soups. The tomato is produced over a larger part of the United States than any other vegetable. It may be handled with few and simple appliances, and may therefore be canned in the home and in small factories where little capital is required, as well as in the large factories.

The development of a tomato suitable for canning purposes has been a specialty in itself. For canning the fruit should be moderately large, smooth, so that it will peel readily, ripened evenly to the stem, of a clear, red color, and having a large proportion of solid meat of good flavor. Varieties which ripen unevenly or are irregular in outline are difficult to peel and the percentage of waste is too high. Tomatoes which are yellow or purple do not have an attractive appearance on opening, and those with excessive seed cells or which are soft and watery will give the can the appearance of being slack filled or packed with water. A good pack is therefore dependent upon having a variety possessing the right qualities. The canner can not accept tomatoes of a half dozen or more varieties and get good results. He must therefore specify the variety grown or furnish the plants for his growers. The production of plants in hotbeds and cold frames to supply several hundred acres is of itself a very large task. The plants are grown in the field, the same as other crops, and a single large cannery will use the product of 1,000 acres. One ketchup manufacturer takes the entire product from more than 5,000 acres. A fair yield is 5 tons of fruit for an acre, but good cultivation and fertilization sometimes brings this up to 20 tons or more. Thirty-three bushels weigh about 1 ton.

At harvest time the fruit must be picked every day, or every other day, in order to insure collecting it when it is in its prime—just ripe, without green butts, and not overripe. It is preferable that the tomatoes be put in crates which are wide and flat rather than deep, and which will hold not more than a bushel. They can be delivered to the factory in better condition in the flat crates than in the deep ones or in baskets, as the fruit will crush if piled in too many layers. Arrival in good condition lessens the time required for peeling as well as the loss in parts cut away. The tomatoes should be delivered to the factory promptly, as deterioration begins soon upon standing.

When the tomatoes are delivered at the factory they are weighed, and inspection should be made of each load. One crate is taken out at random and dumped into a tank of water. All defective fruit can be detected at once, picked out, weighed separately, and the load docked accordingly. Rotten fruit can not be used and green fruit must be held to ripen. The separation at the factory entails extra expense in the inspection and sorting. The rotten fruit should not have been picked and

the green should have been left in the field; the only way to reduce this waste to a minimum is to employ a system of dockage.

The first step in manufacture should be proper sorting. This can be done better by a few persons than by the many peelers. Tomatoes which are green should be taken out and held in crates for one or two days, as may be necessary, but small green spots may be cut out by the peelers. The tomatoes with rot should be discarded. Tomatoes which are small, rough, misshapen, and sound, but which will not peel well, can be set aside for pulp. Such a separation will lessen the work and waste in the factory and in the end be economical. The sorting is best done upon a conveyer table, the tomatoes which are passed being fed directly into the washer.

The washing should be thorough and done without bruising or crushing the fruit. It is preferable that the fruit be dropped into a tank of water and rolled over and over gently, either by actually turning the tomato or by strongly agitating the water, and then spraying under a strong pressure as they emerge from the water. This latter operation is of greater importance than is generally supposed. As before stated, a comparatively large volume of water without force behind it is far less efficacious than a much smaller volume having force. The latter cuts off the dirt and organisms, the former only wets the skin and makes it look bright. Allowing tomatoes to dry in the sun after washing by each method will clearly demonstrate the difference. The water in the tank should be changed continuously by the addition of the water used in the spray, an overflow being provided for the tank. The majority of tomato-washing machines are inefficient.

The tomatoes are scalded, while passing slowly through a tank or steam chamber, by the continuous action of hot water or steam. The scalding is only sufficient to loosen the skin and not to heat or soften the tomato. As the tomato emerges from the scalder it is sprayed with cold water, which causes the skin to split and arrests the heating of the fruits.

The clean-scalded tomatoes are delivered to the peelers in various ways, in pails and pans by carriers or belts, or by moving table tops, or they are delivered to the tables directly upon belts. Various devices have been used to carry the tomatoes to and from the peelers and to care for the waste, the object being to secure cleanliness and careful handling of the fruit. The bucket system is an old one and is in general use at small factories. The bucket is filled with scalded tomatoes and the peeler works from one bucket into another, dropping the refuse into a third bucket or into a trough under the table. The objection to the bucket is that the fruit on the bottom is mashed more or less before being reached by the peeler, and the same is true of the peeled fruit. Wide shallow pans have an advantage over the bucket in this respect. In peeling from the special tables, the tendency is to heap the bowls too full, which produces the same disadvantages found in using the bucket. Some paint the buckets different colors to indicate whether they are to be used for scalded tomatoes, peeled tomatoes, or refuse. All buckets or pans should be washed each time they are used, no matter how many times a day that may be. All tables and conveyers should be washed each time the plant stops, and oftener when needed.

The peelers hold the tomatoes with the stem toward the palm of the hand, pull the skin back from the blossom end, and close the operation by removing the core with the point of the knife, keeping it well directed toward the center so as not to open the seed cells. This is not only the quickest way to peel the tomato, but keeps it whole. Green and undesirable spots are cut out.

The cans are filled either by hand or by machine. The sanitary or open-top cans are filled by hand, as it gives a better appearance to the finished product. In this class the cans are weighed to insure the desired fill. If filled too full, which may easily happen, "springers" or "flippers" may result, and the product be unsalable though perfectly wholesome. "Springers" or "flippers," as before explained, have the appearance of a swell, but are not due to fermentation. Solder-topped cans

seldom bulge in this way for the reason that they can not be sealed when too full, and, as a rule, they weigh from 3 to 4 ounces less than the hand-filled cans. Overfilling also necessitates a longer process, breaking up the fruit and detracting from the appearance of the product. In order to bring out the flavor some canners add one teaspoonful of a mixture of equal parts of salt and sugar, or of one part of salt to two parts of sugar, to each can. This is rarely done except upon high-grade goods and must be done by hand in order to insure uniformity.

There are several types of filling machines for solder-topped cans. A type in use for some time consists of a chamber to hold a quantity of tomatoes sufficient to fill a can, and a plunger or piston to force them in. The result is that the fruit is more or less badly broken, though just as good in quality as the handpacked. Some of the latest machines fill the cans on the principle of the collapsible tube, resulting in a much better appearing product than with the old type. During the last season machines were designed to fill the open-top can. All fill by volume rather than by weight. When the filling is done by hand the product is often designated "hand-packed" or "solid-packed," to distinguish it from that filled by machine, or filled with tomatoes and juice added to fill the interspaces. The use of water in canning tomatoes is unnecessary and constitutes an adulteration. Its only justification has been in the packing of whole-peeled or unpeeled fruit for salads, where perfect appearance rather than food value is the criterion of success. These are packed, one in a flat can, or five or six in a single layer in the large flat can, every effort being made to retain the fruit whole. The quantity packed is very small and equally good results can be obtained by using juice in place of water. The use of about 4 ounces of juice in filling the interstices in fancy selected stock materially increases the amount of whole fruit on the cut-out and adds somewhat to the appearance. The juice used for this purpose should be of the same grade as the stock and not made from trimmings.

The packing of tomatoes results in two classes of product: (1) That in which only whole stock or solid pieces are used; (2) pulp or purée. The two products are distinct and both have useful places, but one should not be substituted for the other. The term "canned tomato" applies to whole or solid fruit and not to the mixture.

The regular packed tomatoes should be well exhausted, sealed, and processed for from 35 to 55 minutes; the more solid the pack, the heavier the process required. Thirty-five minutes is not safe with most packers nor when cooling is practiced. For fancy tomatoes it is better to exhaust slowly to about 120° F., as there will be less breaking down of the fruit than if it be subjected to high heat for a shorter time. The length of time given in processing depends upon the condition of the fruit; if soft-ripe and closely packed, it will require a longer time than if firm and sound. This rule, the reverse of what is generally supposed to be true, applies throughout canning. The softer and mushier the consistency, the harder for the heat to penetrate. Some packers process in the retort at 220° to 230° F. for 25 minutes, but this has the effect of breaking the fruit. It is preferable to cool the can, as there will be a gain of from 1 to 3 ounces in solids on draining and a better color.

Somewhat too much stress is being placed upon the quantity of solid meat which will be found in a can of tomatoes after draining on a screen. A very high percentage of solid meat may mean the use of a variety which is hard and inferior, or fruit which is slightly green, in which event the flavor is deficient. The full rich flavor of the tomato is not developed until it is thoroughly ripe, so ripe that the processing will cause a part of the tissue to break down and after long shipments it may be badly broken. While it is desirable to have a large proportion of the fruit whole or in large pieces, a broken condition is not necessarily evidence of poor stock or improper methods.

The addition of juice or water to cans has a direct effect upon the cut-out, the difference being in the quantity and specific gravity of the liquid portion. The effect of adding water is shown in the following table:

Cut-out weight of solids and juice when varying quantities of water are added to tomatoes, No. 3 can.

Water added.	Gross weight.		Net weight of contents.		Weight of fruit.		Weight of liquid.		Specific gravity of liquid.
Ounces.	*Grams.*	*Ounces.*	*Grams.*	*Ounces.*	*Grams.*	*Ounces.*	*Grams.*	*Ounces.*	
[1] 0	1,100	39.3	960	34.3	647	23.1	313	11.2	1.023
0	1,101	39.3	962	34.3	597	21.3	365	13.0	1.022
2	1,106	39.5	964	34.4	546	19.5	418	14.9	1.021
4	1,107	39.5	969	34.6	507	18.1	462	16.5	1.020
6	1,108	39.5	972	34.7	481	17.2	491	17.5	1.018
8	1,098	39.2	963	34.4	422	15.1	541	19.3	1.018
10	1,091	39.0	953	34.0	399	14.2	544	19.4	1.017
12	1,063	38.0	932	33.3	380	13.6	552	19.7	1.014
14	1,055	37.7	904	32.3	303	10.8	601	21.5	1.013
16	1,040	37.1	899	32.1	274	9.8	625	22.3	1.011

[1] Solid pack, 1911. Much better tomatoes than those which follow of the 1912 pack.

The manufacture of pulp, either as a main product or as a by-product in canning, should receive special consideration. First, there is the necessity for careful sorting, and, second, for thorough washing. Both of these operations are much more important than when tomatoes are canned, for in that case the peel, with any adherent dirt or defective material, is removed.

In the making of pulp as a by-product more or less of this objectionable material is rubbed through the sieve and can not be eliminated. For this reason sorting must be done as the first step, for it is not practicable to do it after scalding or for the peelers to do it. The washing should be of the most thorough character—first by placing the tomatoes in a hopper containing water to soak the dirt loose, and then by passing the tomatoes under pressure sprays so that all parts are exposed to the action of the water. The ordinary grasshopper or dump washer does not accomplish this end. The best washer is that used for cleansing lye-peeled peaches. It consists of a cylinder made of perforated, corrugated iron, mounted and rotated as a squirrel cage. A pipe with fish-tail nozzles directs streams of water upon the fruit at intervals of about 10 inches. The tomatoes can not slide through but must roll over, and are not handled roughly. The treatment is more vigorous than is necessary for canning operations, but is right for pulp or ketchup. With proper preliminary treatment and careful work upon the tables, trimmings need not be objectionable for pulp and are a proper source for good food material. Where tomatoes are very large and badly wrinkled the loss in solid packing reaches as high as from 50 to 60 per cent, whereas a considerable portion might be saved. The trimmings from the tables should be worked through the cyclone promptly; otherwise fermentative processes will take place.

In the manufacture of pulp as a main product, using the small, irregular, cracked, and soft-ripe fruit, the same care should be given to sorting and washing. The tomatoes may or may not be run through a scalder and go at once to the cyclone. The scalding gives a better result than the use of a crusher without scalding. The paddle beaters in the cyclone should be set back and not be made to force everything through the screen except hard fiber. By being set back the hard parts are not torn to pieces; green butts, brown mold, and corky parts are thrown over the end. On the two operations of washing and cycloning alone the difference in the amount of organisms in the product may be influenced 50 per cent or more.

A large proportion of tomato canners could advantageously sort only the finest fruit for peeling and work all other sound stock into pulp. It would eliminate from the cost of peeling much that is expensive to peel, would reduce the waste to the minimum, and lessen the number of employees required. The first operation in preparing tomatoes for soup in the kitchen is to run the contents of a can through a sieve and concentrate over the stove. This work could be done better by means of proper equipment at the factory. The contents of a No. 3 can would be reduced to that of a No. 2

can, with saving of labor, cost of cans, and freight. There is little excuse for packing seconds and pieces of tomato in juice for soup stock when a better quality can be prepared in a more concentrated form, and the water can be obtained at home at less expense.

The cooking of the pulp may be done with coils or in jacketed kettles, there being a preference for the former. It may be only slightly boiled or it may be condensed more than 50 per cent, depending upon the trade for which it is intended. Heavy pulp is canned in No. 1 and No. 2 cans for family use and light pulp in 1-gallon and 5-gallon cans for ketchup manufacturers. No standards have been made for pulp, and as a consequence there is no uniformity in the products found upon the market. The boiling pulp is run directly into cans and sealed; the process varies with the consistency and length of time taken for condensing; No. 2 cans generally receive 25 minutes at boiling temperature, and 1-gallon and 5-gallon cans, 30 minutes at 190° F. A good many packers steam the 5-gallon cans, fill them while hot, seal, and do not give a subsequent sterilization. This practice, however, is dangerous.

Until recently the tomato was packed almost exclusively in No. 3 cans, but with the introduction of the open-top cans No. 1 flat, No. 2, and No. 2½ cans are rapidly coming into use, as they furnish more nearly the amounts required in household use. There is also a large quantity of so-called gallons put up for hotel trade.

Condensed tomato or purée prepared from sound material has many advantages for some purposes over the regular canned article, and its use should be cultivated, especially for soups, etc. At the price paid for the standard grade of tomatoes a better article can be obtained as a purée or paste. Some purée is made from peel and waste from the canning. If the material is clean and sound there is no objection to its use, but too often this is not the case, as is made evident by the presence of microorganisms, broken tissue, and products of decomposition. A paste which is made from the whole tomato and from trimmings by a system of spontaneous fermentation and salting is used largely by foreigners. This article is no longer permissible in interstate trade. Another grade of paste is made by evaporating the pulp until it becomes very stiff and heavy. The straining of the juice or pulp from the seeds and hard portions can be done better and with less waste by special machinery than in the kitchen.

Tomatoes are sold under various trade grades, as extra choice, extra select, choice, select, extra standard, standard, and seconds. It is unfortunate that there are so many ways of designating the contents of a can, particularly when the prefix is meaningless. What one packer calls his "extra choice" or "extra select" may be no better than an extra standard or a standard of another packer. The real grade at present is dependent upon the packer's name, not upon what he claims. There should be but two grades—selected or first grade, and standard or field run for the second. A can of first grade tomatoes should be from selected, prime, ripe fruit, having a fleshy body, well-developed flavor, and uniform color. The can when opened should be full and most of the tomatoes whole or in large pieces, free from all peel, core, or defects. The net weight should not be less than 32 ounces in a No. 3 can.

A can of standard tomatoes should be from sound, ripe fruit, having a fair body and good flavor. The can when opened should be full, and part of the tomatoes whole or in large pieces. They should be well peeled and cored. The net contents of a No. 3 can should not weigh less than 32 ounces.

MARINE PRODUCTS.

There is a very large variety of fresh and salt water products put up in cans, and these have received the following classification by Charles H. Stevenson:[1]

There are five general classes of canned marine products, viz, (1) plain boiled, steamed, or otherwise cooked; (2) preserved in oil; (3) prepared with vinegar, sauces,

[1] The Preservation of Fishery Products for Food. United States Fish Commission Bulletin for 1898, p. 512.

spices, jellies, etc.; (4) cooked with vegetables, etc.; and (5) preserved by some other process, but placed in cans for convenience in marketing.

The first class includes salmon, mackerel, herring, menhaden, cod, halibut, smelt, oysters, clams, lobsters, crabs, shrimp, green turtle, etc.; sardines almost exclusively make up the second class.

The third class includes various forms of herring prepared as "brook trout," "ocean trout," etc., mackerel, eels, sturgeon, oysters, lobsters, crabs, etc.

The fourth class includes fish chowder, clam chowder, codfish balls, green turtle stew, terrapin stew, and deviled crabs.

The fifth class is made up of smoked herring, halibut, haddock, carp, pickerel, lake trout, salmon, eels, sturgeon, etc., and brine salted mackerel, cod, and caviar.

Crabs (Callinectes hasta).

Canned crab meat in this country was the result of experiments made by James McMenamin, of Norfolk, Va. He began at Norfolk in 1878, but moved to Hampton in 1879, and that has been the chief point of supply up to the present time. The season for catching crabs is from April to October.

The live crabs are placed in large crates, well washed, and then run into a steam box, where they are cooked for 25 minutes. After cooling they are "stripped"—that is, the shell, viscera, and smaller claws are removed. The meat is then picked out of the bodies and large claws by hand, or it may be removed by centrifugal force or by compressed air. The latter methods, which are of recent origin, are effective and save much labor. In the centrifugal method the shell and claw are cut across to expose the tissue and a quantity so prepared is placed in a centrifugal drum almost the same as that used for drying in a laundry. The drum is made to spin at a high speed and all the meat is extracted. The compressed-air method consists of an air compressor and a storage tank, with pipes leading to a nozzle. The shell is held in front of the nozzle, the air is turned on, and the meat blown out. Either method is faster, better, and cleaner than the hand picking.

The meat is filled into cans and processed. The No. 1 cans generally used are first heated for a half hour in boiling water, vented, and then processed for one hour at 240° F.

Crab meat is not so easy to keep as some other kinds, the tendency being to blacken more or less in the cans.

Oysters (Ostrea virginiana).

The oyster is a marine bivalve of the genus Ostrea, the species used in this country being *Ostrea virginiana*. It is found along the coast, chiefly in the shallow waters at the mouths of rivers and in bays. Chesapeake Bay has long been noted for the abundance of its oysters. They are found naturally all along the Atlantic coast as far north as Massachusetts, and at one time were abundant in Long Island Sound. Active dredging depleted the beds and now the supply is maintained only by cultivation and the restriction of dredging operations. Some oysters are canned on the coast of Virginia, the Carolinas, and Georgia, but they are no longer canned north of Maryland. The oyster occurs in the Gulf on the west coast of Florida and all along the shore to Texas. There is a large business in canning oysters in Mississippi and Louisiana. A few oysters are found on the Pacific coast, but not in sufficient quantity to warrant canning. The abundance of oysters in Chesapeake Bay made canning operations most profitable there, and the output acquired a reputation which still gives it some preference in the market. Prior to 1900 probably 95 per cent of the canned oysters were put up in Baltimore or in the immediate vicinity. The southern or Gulf oyster, however, has been proved to be equally good for canning purposes and the industry has rapidly assumed large proportions in those localities.

The oyster grows naturally on the hard reefs in from 15 to 180 feet of water, depending upon the temperature. In the Gulf they grow in shallower water. They will also grow in the bayous and flats by transplanting and furnishing shells or hard objects

to which the spawn may become attached. Formerly no regulations were deemed necessary as to the places at which oysters might be taken, but since the rivers have become polluted with city sewage, it is necessary to guard carefully against oysters from contaminated beds. The different States regulate the time when the fishing may be done, which is generally from the 1st of September until the 1st of May. The oysters for canning are usually taken from the beds between the 1st of October and the 1st of April.

Oysters were among the first products canned in this country. It is recorded that some were put up in an experimental way in New York in 1819, though they did not become a commercial proposition until the work was developed by Thomas Kensett in Baltimore in 1844. In the beginning all the oysters were shucked raw, by hand. In 1858 Louis McMurray, of Baltimore, found that by scalding the oysters in boiling water the shells would partially open and the labor of shucking could be lessened. Two years later the system of steaming them instead of scalding was developed, and no material change in method has taken place since that time. McMurray is said to have had a most excellent reputation as an oyster packer. His method was to save all the liquor and condensed steam from the steam boxes, filter it, and use it in filling the cans. He used neither salt nor water. There is probably no packer in the business at the present time following this method.

Oysters are obtained by dredging and by tonging, the former upon the reefs and in the deeper water, and the latter in the shallow bayous where planting has been done. The usual equipment consists of a schooner of about 48-foot keel, 55 feet over all, and 16-foot beam. When loaded, this will carry about 275 barrels of oysters. The crew consists of a captain and four men. A dredge is carried on each side of the boat and operated by two men. The dredge consists of a heavy iron rake about 3 feet wide, to which is attached a chain or heavy cord purse, the mouth of which is held open by an iron bar just above the rake. The dredge is lowered to the ground and dragged along by the movement of the boat. The rake loosens the oysters from the rock or ground and they are collected in the purse.

At short intervals the dredge is drawn on board by means of a windlass, the purse is emptied, and the operation repeated. The oysters are culled in some places, the small ones being returned. The catch is put in the hold if the boat is out in warm weather or is to be gone for more than a day. The trips are generally limited to from three to five days in order to insure delivery in a fresh condition at the cannery. Other varieties of smaller boats are also used, though power boats are generally barred. The Gulf-coast factories pay about 60 cents per barrel for oysters used in canning and 80 cents per barrel for those used in the fresh trade, owing to the difference in size. The barrel is rated by measure and not by weight. On the eastern coast the measurement is by the bushel.

The oysters are rated by size. If there are from 800 to 1,000 to a barrel they are known as standard, from 600 to 800 per barrel as selects, and from 450 to 600 per barrel as extra selects. The largest oysters, known as "counts" on the east coast or as "plants" on the Gulf coast, run less than 450 per barrel and are always sold raw. The larger oysters are found on certain reefs on which work has been prohibited for given periods or in certain water where planting has been done. The term "plants" when applied to eastern oysters refers to those taken from deep water, transplanted in shallow water, and cultivated until they have attained a desired size.

When the oysters are brought in, they are hoisted directly from the boat to the steaming car. These iron cars or crates are 28 inches wide, 19 inches deep, and 8 feet long. They will hold 5 barrels of 2½ bushels each. As soon as the car is filled the oysters should be given a thorough washing with clean water to remove the dirt and mud attached to the shell before it goes to the steam box, otherwise there is contamination during the shucking. The cars are wheeled from the dock to the steam

box, which accommodates 3 cars. The steamer is a rectangular iron box, just large enough to admit the cars, and is 25 feet in length. There are a few variations from these sizes, but these are standard. The doors are closed at both ends; steam is turned on until a pressure of 10 pounds is reached, and this is maintained for 5 minutes. The doors are then opened and the oysters allowed to cool quickly in the air. It is important that the oysters be steamed well so that there will be no shrinkage in the can, but not long enough to cause them to become crummy. Both the time and the temperature at which the steaming is done seem to have been fixed by experience, as none of the superintendents seemed to know what the effect would be if a lower temperature and longer time or higher temperature and shorter time were given.

The car of steamed oysters is pushed into the shucking shed, the shuckers standing around the car and working until it is emptied. The usual number of shuckers is from five to eight, and they are generally women and children.

The steamed oyster has the shell partly opened, the meat being easily removed by means of a short, heavy-bladed knife. The oysters are deposited in pans which are hooked to the oyster car. The shucker receives 5 cents for 3½ pounds of selects or 3 pounds of standards. The oysters are weighed as received from the shuckers, washed, and placed in cans by weight according to the grade and order. The cans are filled with a weak hot brine (2 pounds of salt to 10 gallons of water) frequently by passing the cans through a dip box. This method was used at one time in other lines of canning, but has been superseded by more sanitary methods, and should be in this case.

The cans are capped in the usual manner, either by hand or machine, and are then processed in the retort at 240° F., the No. 1 cans for 12 minutes and the No. 2 for 15 minutes. The different packers vary the time a few minutes, but practically all use the same temperature.

The oysters are cooled as soon as sterilized, and when dry are ready to pack. The oyster is easily sterilized, it is not hard on the can, and there is little loss from spoilage.

The term "cove" is applied to any canned oyster. It originally meant only the oysters obtained on the western shores of Chesapeake Bay and was distinctive of quality. Gradually any oyster became a cove oyster, and now the term refers to canned oysters irrespective of where they are obtained.

Salmon.

Salmon canning on the Pacific coast is one of the large canning industries, and is of so much importance that Government aid is extended in maintaining fish hatcheries in order to keep up the supply. The first salmon canning was done on the Sacramento River in 1864, later on the Columbia River in 1866, in British Columbia in 1874, and in Alaska in 1882. The value of the salmon pack on the Pacific coast is more than $10,000,000 annually.

There are four species of salmon which have large commercial importance—*Oncorhynchus tschawytscha*, the chinook, quinnat, red spring, or King Alaska; *O. nerka*, the sockeye, blueback, or redfish; *O. kisutch*, cohoe, silver, or silver sides; and *O. gorbuscha*, humpbacks or pink Alaska. Preference is given to the bright pink color by the consumer, but for real quality the paler cohoe excels some of the others, the flesh being less dry and containing more oil and a better flavor.

The salmon are caught in the rivers as soon as practicable after they leave the sea on the way to the spawning grounds. They are caught by nets, seines, traps, and fish wheels. The catching of the fish is done on an elaborate scale, an idea of which may be gained from a brief description of a trap. This consists of a steel-wire netting, starting at the shore and carried out into the stream at an upward angle for a distance of about 2,500 feet. This netting is supported by piles placed about 15 feet apart. At the outer end is a large square compartment known as the pot. This is usually about 40 by 40 feet and in water as deep as 65 feet. This pot contains a dip net equal to its area. Just previous to reaching the pot the trap is made to zigzag or assume a heart shape, so that the fish in trying to pass up the stream will be directed into the pot.

Adjoining the pot is a spiller, which is similar in construction, but of smaller size, having a tunnel or opening connecting the two. The fish pass from the pot to the spiller and are taken out by the dip net or brailer, which is 12 by 12 feet and is cast and drawn on board the boat by power, literally lifting out hundreds of fish at a time. They are hurried to the factory as rapidly as possible, where they are unloaded upon the dock by means of elevators or pews.

It is the general practice to permit the fish to remain out of water in bins for 24 hours before canning, as a certain amount of shrinkage takes place; otherwise there may be excessive blowing of the juice on venting. The fish are washed free from slime or gurry before they go to the butchering room.

The dressing of the fish, or butchering as it is called, is done speedily, mostly by machinery. The head and tail are sawed off on a band saw, where formerly they were cut off with a cleaver. The fish is then fed into the "chink" tail first and back down. By the revolution of this wheel, the fins are removed by special knives, the body is split open, the viscera torn out, and the interior wall scrubbed by revolving brushes. The dressed fish is delivered into a tank of water, and the offal delivered with the gurry. The iron chink does a better job than is done by hand, and is the most important machine in the canning of salmon. After the fish has been dropped into the tank of cold water, it is scrubbed thoroughly with brushes until it is clean.

The dressed fish is placed upon a special slitted elevator, which feeds it transversely into a series of revolving disks, which cut it into lengths corresponding to the height of the can. There are a variety of lengths used, but there are three which are standard; the No. 1 tall, No. 1 flat, and the half pound. Seven knives are used in the gang for cutting for tall cans, 13 knives for flat, and 17 knives for half-pound cans.

The grading of the fish is done on the basis of solid and less desirable body cuts. The filling of the choice parts is done by hand, and each can weighed. The short weights are supplemented by bits, but overweight is not reduced. Much of the filling, especially of the less expensive cuts, is done by machinery. The cans used must all be open top, and this is later either soldered or the joint made with a double seamer.

The solder capping of the cans is different from that practiced in other packing. First a piece of tin with the corners bent up is placed on the fish, then the can is set in a machine which wipes the upper edge, after which the end is put in place, and the can passed through another machine which crimps the end to the sides. This end contains a small hole or tip. The can then rolls, head downward, into a V-shaped groove which contains flux, and continues its rolling in another section of the groove containing solder, and it is here that the final sealing is done. The heating of the contents, due to the hot solder, causes some steam to be generated, and it is for the purpose of allowing this to escape that the piece of tin is placed within and under the vent. When the can leaves the soldering trough it is turned over and the vent closed or tipped. With sanitary cans no tin nor vent is needed, the cap being attached and sealed by machinery.

The cans are then placed in trays, the standard size being 35 inches square and 3 inches deep. Each tray will hold 160 tall or 86 flat standard No. 1 cans, the cans being on end in a single tier. The test for leaks is to set the tray in boiling water for a few seconds and watch for bubbles. Eight trays make a basket, and this constitutes a charge for the retort.

The process consists of heating at 220° F. for 30 minutes, then taking out the fish, venting, and retipping, and giving a subsequent heating for 1 hour and 15 minutes at 250° F. When open-top cans are used, the filled cans are run through an exhaust box very slowly so that they are thoroughly heated before the cover is attached. Venting becomes unnecessary, but the time of cooking remains unchanged—that is, the single heating is equal to both periods under the old method. The hot cans are immersed in lye to remove grease and oil and are then cooled in water. The net weight of the 1-pound tall or flat can should average 16 ounces.

Sardines (Sardinia).

The sardines caught on the Pacific coast are much larger than those taken in the East and are handled in a different manner. They are caught in nets at night, and on being brought to the factory in the morning are put into bins and kept wet with running water for some hours. They are then dressed, scaled, heads and viscera removed, and again thoroughly washed in two or more changes of water. They are next dipped in strong salt brine for a few minutes, rinsed, and placed in wire trays to dry. In order to expedite the drying the trays are carried through a mechanical drier so that all surface water will be removed. The crates are then dragged through a vat of boiling oil, the length of time being that necessary to cook the fish thoroughly, usually about five minutes. They are left in the crates until cool, which is usually until the following day, placed in the cans by hand, oil or sauce added to fill the interspaces, carefully exhausted, and processed at 240° F. for 1 hour and 15 minutes.

Shrimp (Panaeus brasiliensis).

The shrimp is a crustacean and belongs in the same general class as crabs, crayfish, and lobsters. There are a number of varieties found in this country, but the one used for canning is the Gulf shrimp, *Panaeus brasiliensis*. The shrimp found in the fresh waters and west coast are used fresh, but are too small to be used in canning. The Gulf shrimp resembles a large crayfish and is from 5 to 7 inches long. They inhabit the deep waters and come to the shore twice each year. They are active swimmers and are provided with very long antennæ. The abdomen is the only part of the shrimp that is used, the head and thorax being thrown away.

The first attempt to can shrimp was made by Mr. G. W. Dunbar, of New Orleans, in 1867. His efforts did not meet with success until 1875, at which time he devised the bag lining for the cans. In 1880 a factory was started at Biloxi, Miss., and from that time to the present the majority of all the shrimp canned has been put up in these two cities. It is only within the last 10 years that the canning of shrimp has assumed considerable importance, but it is still limited to about a dozen places in Louisiana and Mississippi. A cannery was started in Texas, but failed to secure a regular supply, and the oyster canneries in Florida could not secure enough to make it profitable to prepare to receive them. The early supply of shrimp was obtained from Barataria Bayou, or Lake, which gave the distinctive name, Barataria shrimp. The name is often improperly used now. The shrimp sent to England are called prawns.

Shrimp are caught in February, March, and April, and in September, October, and early November. The run is uncertain, and a catch depends upon the state of the weather; the quantity taken is very irregular. The shrimp are caught only in shallow water along the shore. Previous to 1911 all catches had to be made in less than 6 feet. Newer apparatus has been invented, making it possible to take them in water 10 feet in depth. The shrimp are located by coursing over the ground in a small sailboat, or a skiff, and trying with a cast net. This is a circular net from 6 to 8 feet in diameter, with leads every few inches around the edge and a cord attached for drawing it together. A man stands at the bow of the boat and makes trial throws until a school is located. When the shrimp are found the large seine is anchored on the shore at one end and the boat rowed out and around as large an area as the seine will cover. As soon as the second end is brought to the shore the men bring the two ends together and begin to draw in the seine. If the weights hang close upon the ground the chances for a catch are good, but if the seine should rise the shrimp will find a way out very quickly. The handling of the seine requires wading in water from 2 to 4½ feet in depth. The seine is drawn in such a manner as to cause the shrimp to go into the purse in their attempt to escape.

As soon as the catch is made safe the boat is brought alongside and the shrimp dipped out with scoop nets. They are stowed promptly in the hold of the vessel and well iced if the weather is warm or the trip is to continue for more than a day. The seines used in shrimp fishing are from 150 to 225 fathoms in length (900 to 1,350 feet)

and from 140 to 150 meshes wide. (A mesh is three-quarters of an inch, giving a width of 105 to 112 inches.) The net apparatus for handling the seine consists of a stake with special pulleys near the bottom, so that the seine may be drawn from below without a tendency to raise it off the ground.

The boat equipment for catching shrimp is essentially the same as for handling oysters, so that they are used interchangeably. The seine takes the place of the dredges and windlass, and the crew is usually made up of five or six men. Each boat will carry about 140 barrels of iced shrimp.

Shrimp are weighed instead of measured, a barrel being 200 pounds. The pay for catching is $3.50 per barrel in the fall and $4 in the spring. The fall run is the more certain catch and requires less ice, which makes the difference in the schedule of prices.

When the shrimp are brought to the dock they are stored in ice until ready to use. The ice makes the peeling easier and is necessary to prevent spoilage. The removal of the head and shell is known as "peeling" the shrimp, and this is done for all canned shrimp. The head and thorax break from the heavy tail with ease and a slight squeeze will separate the fleshy portion from the shell. This work is done rapidly; the pay for peeling is about 1 cent per pound. The peeled shrimp are thoroughly washed in two or more changes of water and are then ready for blanching. The blanching consists in boiling the shrimp in salt water, which is done by suspending them in a wire basket in the boiling brine. The time of the blanch is usually about four minutes for the wet pack and five minutes for the dry pack. The salt in the brine is in the proportion of about 1 pound per gallon of water. Up to the time the shrimp go into the blanch they are white or slightly gray in color; the boiling in the brine causes them to become bright pink or red.

The shrimp are turned out upon trays having wire netting. As soon as cool they are filled into cans by hand, each can being weighed. The shrimp are all packed in either No. 1 or No. 1½ cans, the former having 4½ ounces and the latter 9 ounces. There is no attempt at grading.

Shrimp are put up in what are known as dry and wet packs. In the dry pack no liquor is added, while in the wet pack brine is used. The process for dry shrimp is 1 hour at 240° F. or 4 hours at 212° F. for No. 1 cans, and 75 minutes at 240° F. and 4 hours at 212° F. for No. 1½ cans. The process for wet shrimp is 11 minutes for No. 1 and 12 minutes at 240° F. for No. 1½ cans.

The fill of 4½ and 9 ounces in the No. 1 and No. 1½ cans has the appearance of being light weight or slack filled. Experience has shown, however, that close filling causes matting of the shrimp and an unsightly appearance. The wet-packed shrimp are preferred by those who are familiar with the fresh article. They have better texture, odor, and taste than the dry packed. A barrel of good shrimp will pack 190 No. 1 cans or 100 cans of No. 1½.

Formerly shrimp were put up in bulk with a preservative. These were headless (only the head and thorax removed, the shell left on), and since that method of preservation is no longer approved, very few shrimp are obtained upon the market other than canned. Some pickled headless shrimp are put up in 1 to 5 gallon cans for hotels. These are boiled in strong brine for several minutes and put up in a saturated salt solution. They keep, but are very salty, and as it takes a long time to freshen them they are not available for immediate use.

Shrimp are difficult to keep. Put up in the ordinary tin can they will blacken in a short time and will attack the tin, making minute holes. Success in canning shrimp was dependent upon lining the can. This was first done by Mr. G. W. Dunbar, of New Orleans, in 1875. The method consisted in inserting a sack in the can and filling it with the shrimp to prevent their coming in direct contact with the tin. Later a thin veneering of wood, corn husks, parchment paper, asphaltum, and enamels were used. Parchment paper is used by all packers, with possibly one exception, at this time; in this case wood veneer is used.

SPECIALTIES AND SOUPS.

Beans, Baked.

Pork and beans, beans and tomato sauce, and baked beans are the ways which the labels read on the product which a few years ago was known only as "baked beans." The beans used for this purpose are the small white pea or navy bean. They are chiefly grown in New York, Michigan, and Wisconsin and are a regular field crop, sowed, cultivated and harvested when ripe and used only in the fully ripe dried state. The quantity used in this way is enormous.

The beans should be of good quality, small, white, machine cleaned, and hand picked for defects. The first step in preparation is soaking, and this is done in tanks or barrels and lasts from 12 to 24 hours, depending upon the method of handling. The water is changed in the tank about once in 6 hours, or, on the fancy article, about once in 4 hours.

From this point on the preparation varies greatly in different factories. For the very cheap trade the beans are boiled in a squirrel cage or pea blancher for a few minutes before placing them in the can; others boil them very slowly in an iron-jacketed kettle from 30 minutes to 3 hours before canning. Some boil them just long enough to slip the skin, the length of time depending wholly upon the grade of the bean.

Before the cans are filled, a piece of pork is placed in the can, then the beans, and finally the sauce. The sauce varies greatly, though tomato sauce is the most popular at present. This is made from a good heavy pulp, salt, sugar, and spices, the proportions being varied to suit the fancy of the packer. Plain sauce is made with water, salt, sugar, molasses, and spice. It is important that just the proper quantity of sauce be added, for in the processing some moisture will be taken up by the beans, and if too little sauce or moisture is added they will be dry and hard, while if an excess be added they will be sloppy.

In these methods there is no real baking, the beans having been soaked and boiled. They are subsequently heated in the can at a baking temperature, but no moisture can escape, and baking generally implies that the material is subjected to dry heat, usually in an oven. The real characteristic is the change in and breaking up of the tissues with loss of weight, due to the escape of moisture. Formerly baking was done under hot ashes or coals, in clay or brick ovens; now it is done in stoves and special ovens, and the latter may be heated by steam. The same results may be accomplished in superheated steam as in hot air. The difference between baking and roasting is not always clear, but between baking and boiling there is a distinction. The term "baked" beans, therefore, implies that they have been exposed to a dry heat. This is accomplished by heating the soaked beans for a short time, until they soften but do not break open or become mushy. They are then placed in large pans in thin layers and allowed to bake in ovens until they become dry and mealy and develop the characteristic brown color. The beans, when poured upon the filling table, will readily separate from one another. Another method is to place the beans in large trays in the retort and subject them to dry steam until dry and mealy. The result is almost the same as in the oven—a loss of about 8 per cent in weight taking place and giving the same dry baked bean. These are filled in the can and sauced, as has already been described.

The processing of beans will depend altogether upon the method of preparation, usually from 1 hour to 2½ hours for a No. 2 can, at a temperature of from 245° to 250° F.

There is probably no staple canned which presents more variety in quality and flavor than the bean. The best is a high-grade product, the beans used are expensive, and the dressing, if made of tomato, is good pulp, the same care being given in its preparation as is used in preparing any other. Not so much can be said for some of the very cheap brands; the beans used are inferior, the pulp used is from trimming stock, and the object is to get as much water in the can as possible. The net weight of beans in a No. 2 can should be not less than 19 ounces.

Hominy.

Canned hominy is used in every mining and logging camp in the country. It is primarily the diet for the hard worker, but is also used with milk to take the place of a breakfast food in thousands of homes. It was first packed in 1895 by Mr. I. V. Smith, of Delphi, Ind., and almost immediately others followed.

Hominy is made from selected white corn. The shelled grain is screened to take out all small, defective, or split grains, and any chaff or foreign substance. It is then washed and run into the lyeing machine. Here the corn is treated with a hot solution of lye, during which time it is constantly cooked and agitated until the tough hull loosens. The strength of the lye and the length of time required for the cooking vary at different factories; the time of cooking varies from 20 to 45 minutes. After the lye has accomplished its work the grain is run through a huller, which is in reality a short conical "cyclone," which removes the hull and tips.

The grain is next washed in a squirrel cage, pea blancher, or hominy washer. The different canners use very different methods at this point. Some soak the corn overnight in order to have the kernels swell to the maximum before canning; others soak and cook for only a short time, an hour or two; while some fill the cans at once and depend upon the swelling in the process to give the desired result. The soaking has the effect of getting rid of traces of lye, makes a more tender kernel, and a clearer liquor. The cans are so filled that when the process is completed the grains fill the can nearly full and should be covered by only one-fourth inch of liquor. The liquor should be fairly clear and few black tips present.

Sauerkraut.

Sauerkraut is made by the natural fermentation of cabbage in casks. The cabbage heads are stripped of all outside or green leaves, leaving only the white sound head. It is then cut into thin slices in a specially constructed machine. The long, fine-cut cabbage is evenly spread and well packed in casks. To each layer salt is added at the rate of about 2 pounds per 100 pounds of cabbage. The salt is used as flavoring and to modify in some degree the fermentation. If too much salt is used, a pinkish color results; if too little, the fermented product may become more or less slimy. The temperature of the weather at the time of putting up the cabbage also influences the fermentation. If the weather is very warm, the fermentation is too rapid, the product has a very white but more or less slimy appearance, and the cabbage is tough rather than of a natural crispness. If the temperature is very low, fermentation will be arrested. The best temperature is probably between 60° and 70° F., and the process requires about 4 weeks. Fermentation begins as soon as the cabbage is placed in the cask, but there is only a slight rise of temperature as compared with most fermentation processes. A heavy foam rises to the top, which must be skimmed off every day, and when this ceases to form the brine goes down and the process is complete. Use can be made of the kraut at once, though it seems to be better after standing. The kraut will keep in the casks for a long time, provided there is no leakage, and the spoilage is usually limited to a few inches on the top.

Kraut is easily canned, which is the only clean way of dispensing it in groceries in small quantities. The canning should be done where the kraut is made. The shipping of kraut in barrels to distant points to be canned has nothing to commend it and much to condemn it. The repacking in barrels means labor and loss of material, and in too many cases the loss of natural brine, after which spoilage takes place easily. The canning should be done while it is in the freshest possible state at the point of production. Kraut is easily kept. The cans should be filled full, weighed, and sufficient hot water added to fill the can; then exhausted, capped, and processed at boiling temperature for 25 minutes.

Experiments were made upon the fill of kraut in No. 2½ cans with the following results: Kraut 690 grams, can packed full, gave as a finished product a gross weight of 930 grams, solids 680 grams, liquor 110 grams, the brine lacking more than 1 inch of covering; kraut 590 grams, the can full but not so tight as in the former, finished, the can weighed 920 grams, the solids 600, liquor 180 grams. The brine did not cover by nearly three-fourths of an inch and the can was evidently overfilled. The third lot contained kraut 490 grams, and finished the gross weight was 915 grams, kraut 510 grams, and brine 265 grams. The brine did not quite cover, but the condition was very good.

A properly filled No. 3 can should not contain less than 22 ounces of kraut as determined by emptying upon a sieve of one-eighth inch mesh and allowing to drain for two minutes.

Soups.

Soups of almost every description may be obtained in cans. There is no standard, but each one is made according to the formula of the particular packer. Some soups are concentrated, while others are ready for use. They are practically all packed under Government inspection, both of the plant and the materials used. No meat products can enter interstate trade without being inspected, and since nearly all soups contain either meat or stock made from meat, they must comply with all the requirements governing meat inspection.

Soups are classed as meat or vegetable, though there are but few of the latter that are not made from some kind of meat stock. The usual procedure in making soup is to select the meat stock, which is usually beef, though veal or mutton may be added. The meat used by some of the best factories is of the very highest quality, not merely any meat which has passed inspection. This is cut into pieces, the size depending upon whether it is to be used in the soup or only for the stock, and is placed in large steel kettles. These are heated by steam and covered tightly, so that the stock may be cooked slowly without evaporating. The cooking is continued below the boiling point for several hours, depending upon the kind of meat used and the care given to the making of the soup. The slow cooking has the effect of bringing out the extractives, giving a better flavor and a richer product. The liquor is skimmed at regular intervals, and if the stock is for a clear soup or a bouillon it is clarified with eggs and filtered. If for a soup containing the meat, this last operation may be omitted.

The vegetables used in making soups are carrots, turnips, parsnips, peas, beans, onions, leeks, celery, okra, tomatoes, etc. As far as possible, these should be used in their fresh state, but as it is not possible to have them all fresh at the same time the canned article must be substituted. The vegetables used are prepared separately, washed, peeled, cut into pieces, cubes or special forms, blanched, and in some cases given a separate cooking to get the proper tenderness. These are mixed in the proportions desired, placed in the cans by weight, and the stock added afterwards. The process will depend upon the body, whether thick or thin, and the quantity of meat used.

The making of soups is peculiarly a chef's work; it is not possible to give a formula for so many pounds of meat and vegetables, set a definite time for cooking each, and get a first-class product. The characteristic flavoring depends upon the blending and the condiments used, which is a matter of training and judgment. For meat soups the best packers follow the practice of holding the cans in stock for some weeks in order that they may improve on standing. A good soup requires much work in its proper preparation, much more than is given in the canning of fruits or vegetables. Many soups are made according to formula, and while of good material, are not distinctive.

A list of soups includes the following: Beef, bouillon, celery, oxtail, mock turtle, veal, chicken, chicken gumbo, consommé, green turtle, clam broth, clam chowder, mutton broth, tomato, tomato-okra, vegetable, pea, asparagus, mulligatawny, vermicelli, and Julienne.

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